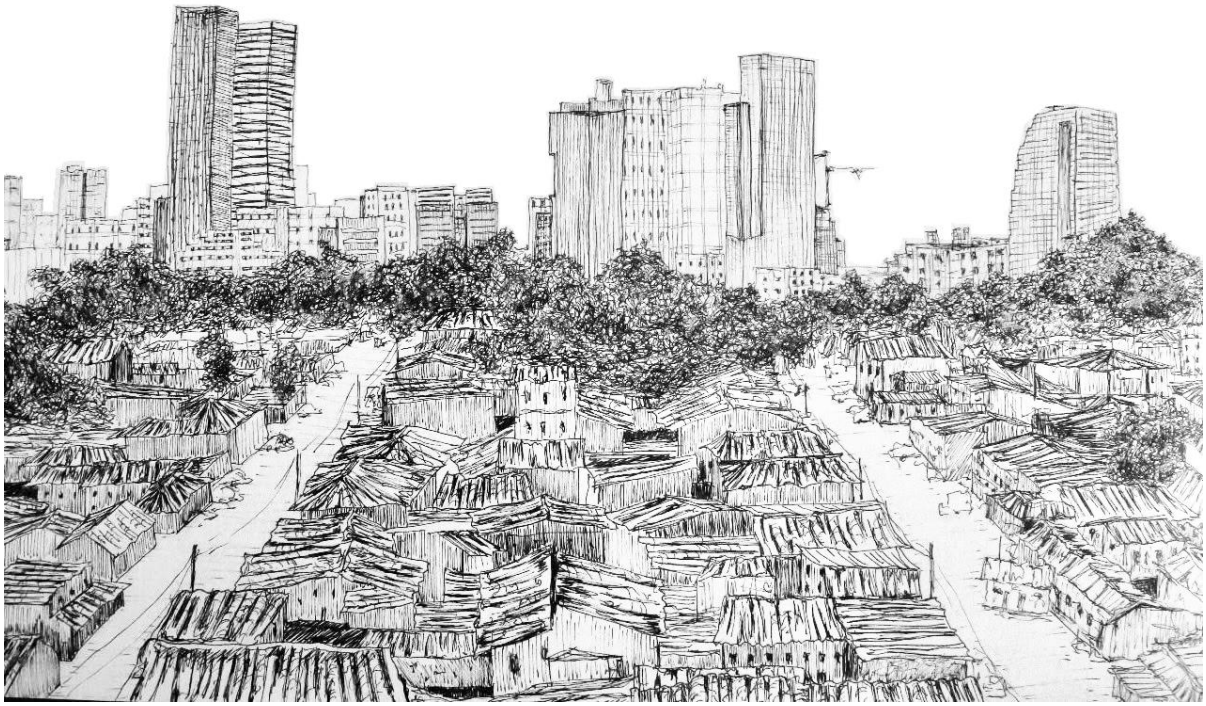
TÉCNICO LISBOA



MUSSUS

Guidelines For The Inclusion Of Musekes In Luanda

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Dissertation to obtain the Master of Science Degree in

ARCHITECTURE

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May 2018

I declare that this document is an original work of my own authorship and that it fulfils all the requirements of the *Code of Conduct* and *Good Practices* of the *Universidade de Lisboa*.

ACKNOWLEDGEMENTS

Obrigada to *Professor Manuel Guedes*, for being an excellent advisor, for our conversations and for consistently motivating me through adversities during this process. Also for familiarizing me to sustainable practices which became my passion in architecture.

Grazie to *Professore Roberto DiGiulio* for making my *Erasmus* experience in Ferrara worth, for introducing me to new ideologies, and improving my first thoughts on this dissertation.

Obrigada to the architects and engineers of the *Sambizanga* Rehabilitation Centre in Luanda, for embracing my visit, explaining the actual processes used in the recuperation of *musekes* in Luanda, which was a great support for the investigation of this dissertation. Thank you, Drª *Elisabete Oliveira,* Arqº *Ilídio Daio*, Arqº *Miguel Dias*, Arqº *Bento Soyto* and particularly Engº *Armindo Machado*.

OBRIGADA, to my parents for supporting my decisions and believing madly in my abilities to fulfil my dreams. Thank you to my close family, my sister *Shelsea*, and friends who helped me through several conversations, *Micaela*, *Soraia*, *Gregory, Wilson* and *Nídia Gonçalves* for introducing me to @ViewsofAngola, that provided a selection of photos of my beautiful country.

ABSTRACT ENGLISH

The present dissertation consists in the conception of a social housing programme for the city of *Luanda*. The main goal is to create guidelines to improve the conditions of exclusion of slums, bringing awareness to contemporary ideologies– sustainability and modularity in architecture – and lifestyle choices – such as self-sufficiency, voluntary work and maintenance. People in slums build their own houses, in order to overcome financial shortages, but the construction processes lack the crucial knowledge that guarantees safety and acceptable living conditions. The **MUSSUS** Programme aims at contributing to this knowledge, creating a module that adapts to the *musekes* identity and individual needs. The houses' design is made through a schematic modular and standardised system, which is adaptable and can be enlarged, and uses strategies of passive design. In the *museke,* one frequently finds that there is little care for the maintenance of home. The house is seen as a provisional place before achieving a better future and is therefore underappreciated. It is particularly important to set an emotional link between the **MUSSUS** archetype and the people themselves, upcoming owners, otherwise, the risk of neglect would remain the same. So the **MUSSUS** concept is established by a standard modular archetype to enable people's participation in the design and creation of the house.

key-words
slum
social housing
standardisation
sustainability
passive design
Luanda

ABSTRACT PORTUGUESE

A presente dissertação consiste na conceção de um programa de habitação social na cidade de Luanda. O objetivo principal é criar diretrizes para melhorar as condições de exclusão dos *musekes*, aplicando conceitos de sustentabilidade e modularidade na arquitetura – e novas escolhas de estilo de vida - como autossuficiência, voluntariado e manutenção em comunidade. As populações têm vindo a construir as suas próprias casas, a fim de superar a escassez financeira, no entanto os processos de construção carecem do conhecimento crucial que garante segurança e bem-estar. O programa **MUSSUS** assiste este processo, criando um módulo que se adapta à identidade dos *musekes* e às necessidades individuais. O design das casas é feito através de um sistema modular pré-fabricado adaptável que pode ser ampliado e destaca-se pelas estratégias do desenho passivo. Nos *musekes*, frequentemente se descobre que há pouco cuidado com a manutenção da casa. A casa é vista como um lugar provisório na busca de um futuro melhor e, portanto, desprezado. Por isso é particularmente importante estabelecer uma ligação emocional entre o arquétipo **MUSSUS** e os futuros proprietários, caso contrário, o risco de negligência permaneceria o mesmo. Assim, o conceito MUSSUS é estabelecido por um arquétipo modular que permitir a participação das pessoas no desenho e criação das suas casas.

palavras-chave
museke
habitação social
estandardização
sustentabilidade
desenho passivo
Luanda

INDEX

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

CYPE	Software for Engineering and Construction
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GTRU	Gabinete Técnico de Requalificação Urbana Urban Rehabilitation Cabinet of Sambizanga and Cazenga
IYFF	International Year of Family Farming
JEA	Juventude Ecológica Angolana Angolan Ecological Youth
MINEA	Ministério da Água e Energia Ministry of Energy and Water
MPLA	Movimento Popular de Libertação de Angola Popular Movement of the Liberation of Angola
NGO	Non-Governmental Organisation
PDPL	Plano de Desenvolvimento Provincial de Luanda Provincial Development Plan of Luanda
PDGML	Plano Director Geral de Luanda General Master Plan of Luanda
SWOT	Strengths, Weaknesses, Opportunities and Threats
UNITA	União Nacional para a Independência Total de Angola National Union for the Total Independence of Angola
ZEB	Zero Net Energy
km^2	Square Kilometer
m^2	Square Meter
ºC	Degrees Celsius
%	Percent
3 S	Social, Sustainable, Standardised

4

00. INTRODUCTION

"The concern with social housing was abandoned by architects and politicians."
- SIZA Vieira

Home is a place of our own, where we live in family, feel safe and comfortable. However, there are millions of people struggling to live in adequate conditions worldwide, mainly in under-developed countries. This problem affects the continents of South East Asia, South America and Africa.

This dissertation discusses the issues of excluded urban areas in the metropolis of developing countries, focusing on the Sub-Saharan capital of Angola, Luanda. The theme equally explores the 3S's concept in Architecture – Social, Sustainable and Standard solutions – aiming to develop a Social Housing Program, called MUSSUS. This program seeks to empower the refurbishment of slums in Luanda, responding to different families' needs and, producing sustainable, self-sufficient and standardised houses, considering environmental needs and low-budget costs. The program seeks to work at the building and block level, excluding large urban analysis, as well as the energy and water network supplies, despite essential require a specialized investigation work.

0.1. MOTIVATION AND OBJECTIVES

Architecture is known for reacting to social and political circumstances, but it is failing to respond to current issues of informal settlements – slums. Overpopulation and economic injustice in the developing world make slums an acute problem with unprecedented dimensions.

Through research on the dynamics of slums in Luanda, this work aims to develop a Social Housing Programme, in the context of UN-HABITAT and Proficient-EU concepts of slum-upgrading, including bioclimatic design and communal work. From Street-Led to Street-Addressing approaches it is possible to reform the way the streets are experienced in slums, changing the social dynamics of the actual unruly structure. The concept of ZEB house is also introduced, including renewable energy systems, and passive design techniques. Mass-construction of houses is achieved, by modular standardisation, but providing adaptability to each family' needs.

The main goal is to develop a multicable structured project – MUSSUS - that provides the community with the tools to change their environment, significantly improving quality of life.

0.2. METHODOLOGY

The research process started with the consultation of selected bibliography – books, magazines, academic documents and online websites. In particular, research publications from UN-HABITAT were consulted to improve the knowledge on slums, social issues, and community programmes existing in other in developing countries, with conditions similar to Angola.

A field work was also carried out on Luanda's *musekes,* involving questionnaires and interviews. Together with the analysis of case studies based on the 3S's architecture – Social, Sustainable and Standardised – these steps served as relevant references in developing the final project.

The ECOTEC and VELUX software were used assess energy and environmental performance, leading to an optimized modular prototype.

0.3. THESIS STRUCTURE

Chapter 00 INTRODUCTION is the foreword of the dissertation, addressing the author's motivations and objectives, as well as the methodology used in the investigation process.

Chapter 01 FRAMEWORK presents an insight on the worldwide problem of informal settlements. Frames the case of Angola, and its particularities – social, political and economical. The theoretical information is supported by an urban analysis of *musekes* - exploring its evolution and metamorphosis.

Chapter 02 SUSTAINABLE MODULAR SOLUTIONS addresses the State of the Art, acknowledging reference projects in the scope of sustainability, including social-economic aspects, and the use of modularity as a viable design strategy. Later the bioclimatic design strategies are identified and the according passive strategies, for Luanda, are defined.

Chapter 03 THE MUSSUS PROGRAM consists in the definition of the social housing programme – **MUSSUS**. The program's *rationale* is introduced.

Chapter 04 FIELDWORK tackles the visit to the GTRU Centre in Luanda, revealing its current work in *musekes.* The research work resumes with the fieldwork in two – formal and informal - selected Luanda *musekes*.

Chapter 05 CASE OF STUDY ANALYSIS resumes the concept of the MUSSUS program and fieldwork with two final simulation reports – regular and irregular cases – presented with the support of the passive design strategies, energy performance analysis and construction cost.

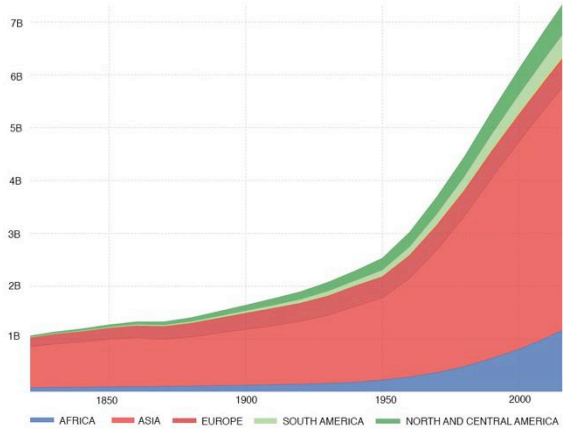
Chapter 06 CONCLUSION AND FURTHER WORK summarises the strong points of the MUSSUS programme. The directions for future research are pointed out.

01. FRAMEWORK

1.1. THE ARGUMENT Slums a Worldwide Issue

In the developed world we are currently living in the most prosperous period in human history, as society overcame basic problems through Industrialisation and Technology. The quality of life improved by the decrease of death rate associated with sickness and starvation. This progress allowed mankind to thrive but other concerns emerged in the process, such as Overpopulation.
According to The World Population Prospect [released on June 21, 2017] the world population is roughly 7,6 billion people, with a strong tendency for increase in coming decades – including in the Sub-Saharan Africa. However, Earth's resources are calculated to accommodate 4 Billion people living by "developed" standards of life (ZINKINA & KOROTAYEV, 2014 : 121).

Access to resources is particularly important for developing countries, where development budgets should not be exhausted on needless investments. (KOCH-NIELSEN, 2002 : 13) Cities in developing countries face acute problems of poverty, exclusion, insecurity and environmental degradation. The ever-widening gap between rich and poor is symbolised by the disparity of the living environment. This is reflected in the contrasting urban forms - exclusive gated communities developing side by side with slums (UN-HABITAT, 2015 : 6).



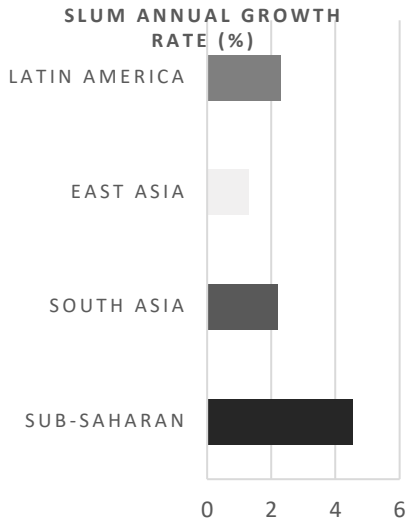
G_01 World population growth by world regions
[OUR WORLD IN DATA, 2016]

The term slum, though represented the same worldwide, often changes its name influenced by *slangs* in developing countries; **FAVELA** [Brazil], **BARRIO** [Latin America], **BASTI** [Bangladesh], **KAMPUNG** [Indonesia], **BIDONVILLE** [France/Africa], **VAROS** [Turkey], **KATCHI ABADI** [Pakistani] and **MUSEKE** [Angola] [CITIES ALLIANCE : online source].

Today, more than one billion people in the world live in slums. In the developing world, one out of every three people living in cities lives in a slum. The word "slum" is often used to describe informal settlements within a city that has inadequate housing and poor living conditions.

UN-HABITAT defines a slum household as a group of individuals living under the same roof in an urban area who lack one or more of the following:

- Protection against climate conditions
- Sufficient living space.
- Easy access to safe water.
- Access to adequate sanitation.
- Security of tenure



G_02 Population Living in Slums. [UN-HABITAT, 2005]

Slums have been part of the history of most cities, particularly in the early years of Urbanisation and Industrialisation, as populations boomed. Today, more than 90 percent of this urban growth is taking place in the developing countries. Slums are also a result of bad governance, which often fails to recognise the rights of the less fortunate, and incorporate them into urban planning; hence, contributing to the growth of slums. Many countries cannot respond quickly to rapid urbanisation, with the rural exodus, people are coming to cities faster than the planning process can incorporate them.

Authorities should identify land and plan for its settlement. Once people settle on the land and feel that they have a right to live there, they will focus on developing the area. The process of empowering slum dwellers hinges on their capacity to engage actively with the government. It is a question of creating an environment on which slum dwellers and governments can engage in a dialogue, about slums and upgrading their communities [CITIES ALLIANCE : online source].

The growth of slums in the Sub-Saharan Africa is far greater than other world regions. All solutions are welcomed – responding to different cultures and different ways of living - the objective of this study is *Luanda*, the capital of Angola.

1.2. ANGOLA Identity of a Nation

1.2.1. HISTORIC CONTEXT

In 1482, the Portuguese navigator *Diogo Cão* encountered the rim of Congo, then contacted the largest *Bantu* Kingdom of Central Western Africa: the *Kingdom of Congo*. For centuries before that, the known inhabitants to occupy the current land of Angola were mainly *Bantu* indigenous groups. Portuguese colonisers remained mostly in coastal areas; the city of Luanda was established as one of the most important commercial trade ports.

In the 19th century, they have managed to develop the inland occupation, as their presence was threatened by other colonialist countries- in the *Congress of Berlin* [1](1884-1885). By the end of 1951 the Portuguese established that every colony, including Angola, would be a part of the territorial land of Portugal, also known as "*província ultramarina*"[2] (WHEELER & PÉLISSIER, 2009 : 25-47).

The increasing occupation of the land by the Portuguese fuelled an emerging independence movement. Angola became independent in 1975, after 13 years of military conflict (1961-1974); as a result things were left unstructured. Angola's independence was followed by civil war, an organisation called MPLA took political power; during this period there were attacks on local communities and high use of landmines throughout the country. Many families escaped to the cities looking for safe havens, this resulted to a drastic increase of the urban population (FAO, 2014 : 13).

The civil war ended in 2002, with the death of the opposite party, UNITA, leader, Jonas Savimbi.

Since the civil war, there has been peace and political stability. The Angolan government has a financial autonomy that came from access to oil, managing to maintain an impressive average annual real GDP growth rate of 11.6 percent. The dependence on the oil's international valorisation created a false sense of security, since its de-valorisation developed an immediate economic crisis. The Angolan government completely disregarded the exploitation of the territory through an organised social effort [e.g. like in the Mozambican agricultural reform], and became dependent of large international companies operating in closed economies or offshore (OPPENHEIMER & RAPOSO, 2007 : 24). Therefore all sectors of the country's structure needs to be revised, fighting off corporate greed. Until these much needed changes take place, poverty continues to be a common challenge for millions of Angolans, with over 54% of the population living in conditions of great poverty.

[1]Congress realised in order to resolve European colonial powers differences and establish new territorial limits to Africa's occupancy. [CHARLES & SÁ, 2011]
[2] *José Ferreira Bossa* declared, in 1944 at the National Union Congress II, that in order to avoid forthcoming conflicts it was relevant to change the arrogant denomination of the colonies as "Colonial Empire" to "Provinces Overseas".

1.2.2. DEMOGRAPHY AND ECONOMIC DISPARITY

The 40 years of colonial and civil wars in Angola impacted the actual demographic structure of the country. A large part of the population was forced to leave their areas of origin, causing migration from rural areas to urban, resulting to a drastic population growth in cities. The capital Luanda was the most pursued option (MINUA, 2006: 2c p1). The preliminary results of the *2014 census* show that on May 16 of 2014, the residents of Angola were 24.3 million. Angola has a surface area of 1,246,700 square kilometres, but with a population density of 19 inhabitants per square kilometre (INE, 2014 : 7).

ANGOLA
Urban Area 15.182.898 inhab 62,3%
Rural Area 9.200.403 inhab 37,7%

LUANDA
Urban Area 6.542.944 inhab 26,9%

F_001 Map of Angola and zoom in of Luanda.
[s: Author adapted from GOOGLE EARTH]

In addition to being the province with the highest number of inhabitants [27% of the total population], Luanda is also the city with the highest population density with 347 inhabitants per square kilometre, this due to its small territorial size [18,834 km^2] (INE, 2014 : 31).

"The unruly urban growth associated with the population displacements caused great pressure on the existing infrastructure, accentuating the phenomenon of poverty." (*cit. in* MINUA, 2006: c2 p2).

The distribution of population growth within a region is much denser in the suburbs than in the urbanised central zones. The density of the population and its expansion to peri-urban areas in the 1980's and 1990's, became increasingly important in the configuration of the urban fabric, sharpening the distinction that marked the two urban structures in the colonial period (OPPENHEIMER & RAPOSO, 2007 : 108).

"This type of urbanization, common in Sub-Saharan Africa, is characterised by rapid urban growth occurring in the face of economic stagnation, poor agricultural performance, rising unemployment, poor governance, and the absence of coherent urban planning policy." Arimah (2011 : 17).

Angola's economy grew by nearly 7% in 2012. However, this does not take into account any contribution from the oil sector; since Angola is the second-largest oil producer in sub-Saharan Africa. Nevertheless, the nation still carries one of the highest rates of poverty in the world.

So where is the oil money going?!

According to the *International Transparency Organisation*[3], Angola takes the 164° position, in a total of 175 countries, reassuring its level of corruption. The main beneficiaries are members of the political elite, as declared by Angolan economist *Fernando Heitor*. (WEYU HODGE: online source).

"The great wealth of Angola should be managed in accordance with the overall interest of the population (...) supporting future generations in promoting their own development." (*cit. in* MINUA: c1 p11)

[3] Organisation that promotes a World corruption free, issuing annually a global ranking report (year 2017).

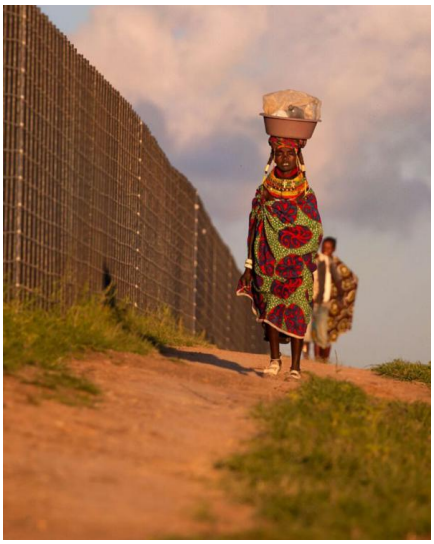
1.2.3. INFORMAL COMMERCE

The extended civil conflict contributed to the occurrence of economic distortions, a fact which was reflected negatively in the emergence of new investments, the stagnation of existing companies and the bankruptcy of thousands of small and medium enterprises; which are fundamental in generating employment and income for the society. This environment created a severe imbalance in job search. Until 1975 Angola was a self-sufficient country, where the agricultural sector was the largest employer. *Since then, there has been a lack of investment in the agriculture sector, in turn, unemployment increased and the living standards became difficult.*

F_002 Candongueiro
[Views of Angola,@hervsfree]

"It is important to distinguish workers who have lost formal employment, who have never had formal employment, and those who only work occasionally under formal conditions. In all these cases the unemployed are not necessarily economically inactive, since they are employed in the informal sector or on their own." (*cit. in* VENNETIER : 30).

In this context, the formal unemployment rate is high in Angola. The quality of hand labour is low and the technical knowledge level of the vast majority of the working masses is not to standard. The distortion of the labour markets, low wages, job insecurity and unexperienced work force resulted to impediment on the development (MINUA: c2 p36). The informal nature of employment reaches 97.6% of Angolans, this unbalanced reality attracts the common people to get informal jobs, men can potentially start a business buying a vehicle [*s. m. candongueiro*] to transport people, and women [*s. f. kitandeira*] usually walk the streets trying to sell anything.



F_003 Kitandeira.
[Views of Angola, @mauro_s3rgio]

candongueiro *(Angola) private/public vehicle of collective passenger transport.* (*Priberam* Dictionary)

The accelerated development of Luanda, made the existing infrastructure inadequate for the high demographic demand, and the chaotic traffic is one of the consequences. By the year 2000 there was, in most cities of sub-Saharan Africa, operation of unregistered vehicles, which served the increased the demand of transportation.

kitandeira *(Angola) Woman that purchases supplies or goods to sell them on the markets or streets.* (*Priberam* Dictionary)

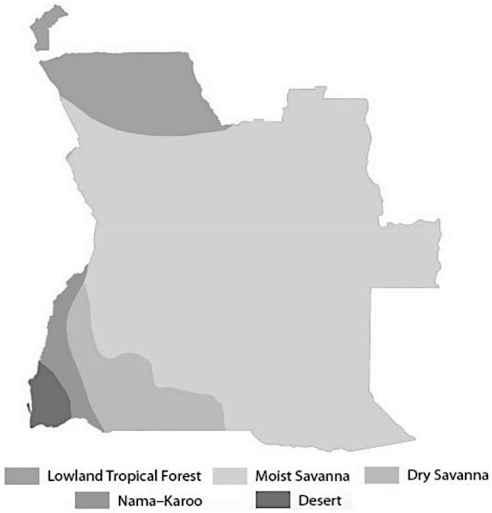
In certain contexts, markets represent institutions that are part of an economic system. In the region of *Luanda*, these institutions were called *kitandas*. According to the writer and Angolan author *Domingos Van-Duném*, the word *Kitanda* derived from *kimbundu*[4] *itânda,* in *Kitanda* plural, which means sidewalk that was used as a place to seat, and exhibit the products to sell.

[4] *Kimbundu* is one of the indigenous dialects based in North Angola. [WHEELER & PÉLISSIER, 2009]

1.2.4. AGRICULTURE AND ENVIRONMENTAL AWARENESS

"Sustainable agriculture is the efficient production of safe, high quality agricultural products, in a way that protects and improves the natural environment (...) and local communities" (*cit. in* FAO : according to SAI).

Angola is a country with strong agricultural potential, owning huge tracts of arable land; able to cultivate sufficient crops to support the production of food and sustain the population as well as being able to export in exchange of financial benefits. Because of the war, agricultural production levels dropped to the point that are insufficient to cover the minimum needs of the population. Especially in the urban area, where consumption is highly dependent on imported goods; such as cereals, edible oils, flour, milk and dairy products. There are three main agroecological zones corresponding to the main climatic and geographical features of the country (MINUA, 2006).



F_004 Map of Angola Climatic Regions.
[s: Author adapted from MINUA]

1. **North** – humid climate;
2. **South** – semi-arid and dry;
3. **Central High-land** – intermediate sub-humid climate.

In the North and Northeast, there is a predominance of cassava, maize, beans and groundnuts. Greater number of corn and beans are grown in the Central High-land area. The South region is mainly known for the production of corn as well as the presence of livestock; these areas are where maize is replaced by cassava, sorghum, millet and beans (MINUA, 2006 : c3 p17). In order to achieve the Sustainable Agriculture goals, it is necessary to first identify the problems and act accordingly. The joint FAO/Government of Angola's Framework, has identified the following as top priority challenges: (FAO, 2014 : 5).

- Rapid urbanisation and high unemployment.
- **Low** agricultural productivity and production.
- *Non-commercialisation* of agriculture.
- Natural resources (land and forest) degradation.
- Improving in an equitable manner the quantity and quality of nutrition.
- **Increasing** the **resilience** of food and agricultural systems to climatic shocks and threats, especially to *floods and droughts*.

Land Area

124670 (1000 Ha)
[FAOSTAT, 2013]

Agricultural Area

59190 (1000 Ha)
[FAOSTAT, 2013]

Forest Area

58105.6 (1000 Ha)
[FAOSTAT, 2013]

In the context of the International Year of Family Farming [IYFF], the Government of Angola, with technical support from FAO, took the initiative in promoting family farming as a means of reducing famine; overcoming food insecurity and reducing poverty (FAO, 2014 : 6). The revitalization of Agriculture is a first step to solve the problem of Slums, calling many of its inhabitants back to their original areas, before the war. The allure for rural lifestyle must be developed in order to bring the dislocated population back in the refurbished home villages where the quality of life is much improved.

"*An important dimension of the degree of human development is the educational level of its people*." (*cit. in* Sabina Alkire, The Human Development, UNICEF, 2002).

Education is indeed a pre-requisite for the development of individual citizens and society in general, with direct consequences on the overall improvement of quality of life, promoting sustainable development and reduction of poverty. The Constitution of Angola recognises the role of the State to provide access to education; however, educational governance of Angola is among the lowest in sub-Saharan Africa. The poor education system has mainly affected the lower class, and as a result, prevented the pursue of better career opportunities; hence, the inability of poorer classes to sustain their family and community (MINUA, 2006). One of the issues discussed in the NGO Forum Treaty of 1992, highlights that environmental education, creates a basis for critical and innovative thinking. Based on this and other documents, JEA makes the following distinction between the three types of environmental education (MINUA, 2006 ; c2 p26);

i) **Environmental Formal Education** takes place in a structured manner and within the formal education systems [i.e. implemented by teachers]
ii) **Environmental Non-Formal Education** happens outside the education system [i.e. through Community programs], is planned and structured.
iii) **Environmental Informal Education** is relatively applied without any structure or planning. [i.e. by the media and personal experience]

To conclude, education enhances the opportunities of the individual in a society, ensuring that the population has the minimum skills to fight poverty (MINUA, 2006 ; c2 p47).

1.3. TERRITORIAL ANALYSIS

1.3.1. URBAN EXPANSION

Luanda is located in the North Western part of Angola, bathed in the West by the Atlantic Ocean and making North land border with the Northern *Bengo* Province, to the West with *Kwanza Norte* Province and the South and Southwest with *Kwanza Sul* Province. It is the second smallest city of *Angola*, with a land area of 18,826 km^2, which represents 1.51% of the national territory extension (PDPL, 2014 : 15).

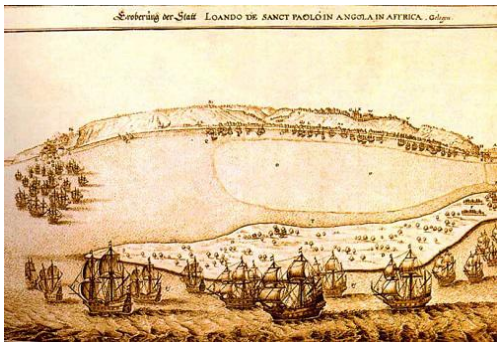
COLONIAL period

Colonialisation has been present in world history since the pre-colonial African empires which led to the Egyptians, Phoenicians, Greeks and Romans who all built colonies in Antiquity. The word *metropole* comes from the Greek *metropolis* [μητρόπολις] - mother city. The Age of Discovery is initiated by the Crown of *Portugal*, followed by Castille, and later enlarged to the remaining European countries. In the preface of "*Colonialism: A Theoretical Overview", Osterhammel (1997)* defines Colonialism as *"a relationship between an indigenous majority and a minority of foreign invaders (...) the lives of the colonized people are made by the colonial rulers for a distant metropolis interest. Rejecting cultural compromises, the colonizers are convinced of their own superiority (...) to rule.*

Before independence, the colonised countries followed a mercantilism[5] policy, and its territories were used mostly as the means to a commercial purpose. The provinces were not developed to achieve self-sufficiency and fuel themselves, rather were developed to obtain maximum profit for the holder's main countries.

1575

"São Paulo de Loanda was founded by Paulo Dias de Novais, its destiny was to be the capital of the Kingdom, due to its privileged location between two major watersheds, rivers Bengo and Kwanza." (*cit in* BATALHA, 2006: 7). The first place to be inhabited was where the S. Miguel Fortress is currently, and in 1576 it is founded S. Paulo de Luanda Village (CARDOSO, 1954 : 3). The city started to lift slowly around this area, stretching across the bay, that was used as a commercial market port, protected by the morphology of the Luanda's island (CRUZ, 2012 :46).



F_005 Porto de Loanda in 1575. [s: Angola Bela]

1700's

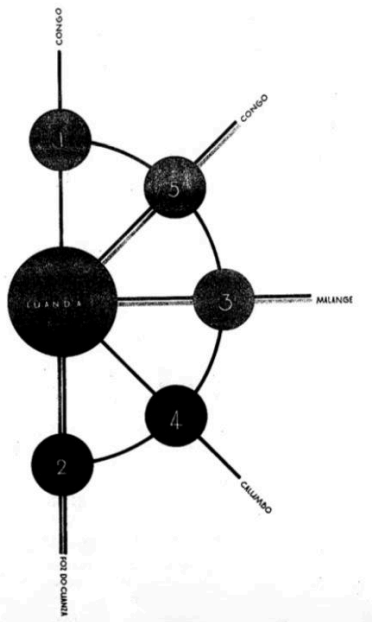
According to author Correia (2012), from 1647, the city was defined by a spontaneous layout, elaborated by settlers who followed the patterns of medieval Portuguese cities. Luanda already had a few urban elements, such as the numerous wide squares that promoted ventilation throughout the city. In addition, streets reveal a perception of orthogonality, however not the same geometric regularity associated with a modern urbanisation (CRUZ, 2012 : 48). The city was developing with a defensive and commercial character, in a perfect adaptation to the local topography, rugged and composed of two distinct zones that complemented each other: the *"Cidade Alta"* [upper-city], the governmental and defensive functions, and the *"Cidade Baixa"* [downtown city], the seaport and commercial functions (FERNANDES, 2005 : 29).

F_006 D. Stadt Loandas Pauli 1616.
[s: Johannes Vingboons, 1665]

[5] Mercantilism is a national economic policy designed to maximize the trade of a nation. [LaHaye, The Concise Encyclopedia of Economics : 2008]

1800's

The Industrial Revolution, in the mid-1800's settled the transition from a world moved by an agriculture based economy to an industrial, mechanized one. Great Britain was pioneer to this phenomenon, and consequently altered the manufacturing production worldwide. Innovations in machinery, methodology and techniques granted the manufacturing of objects in a shorter amount of time and allowed advancements in several areas such as; agriculture, transportation, communication and architecture. The production rate was multiplied and this resulted in price decreasing. The housing production in particular - became faster, more appealing and cheaper - was building continuously - what is now described as modular architecture[6] - and therefore cities grew unprecedentedly. Despite the favourable times this movement also brought its misfortunes. The Industrialisation in urban cities attracted more immigrants, overpopulating the inadequate existent infra-structure, arising the first slums. The rapid-growth acquired by the production in factories, deeply contributed to air and sound pollution. In this context - in an attempt of solving these issues - several theorists and architects developed idealistic theories, a few only graphic, in order to organise the new urban city and principally to improve people's quality of life.



F_007 Luanda's Satelite Plan by Vasco Vieira da Costa, 1948 [FONTE, 2007]

1930's – 1940's

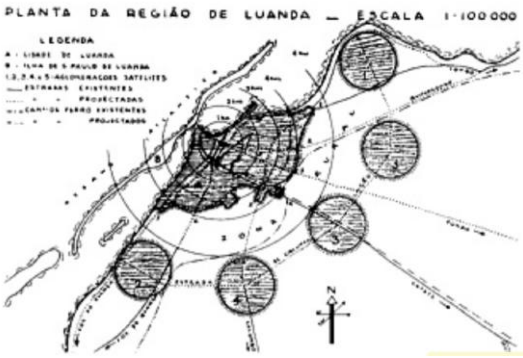
The first city plan that emerged by urban-planners, in 1948, were a formal response for the conservative dictatorship of *Estado Novo*[7]. However, the late modernist principles[8] of post-industrial Europe were applied following a tropical expression. This time's most influential names are *Vasco Vieira da Costa* and *Fernão Simões de Carvalho*, since there was more freedom in building overseas, that made conceivable a M*odern Colonial Utopia* in Angola (TOSTÕES : "Prefácio" in Magalhães). The benefits brought by the supply of electricity was crucial to the development of the population (BETTENCOURT, 2011 : 41). Consequently, informal settlements start to surround the nucleus of Luanda, gaining a radiocentric form (MARTINS, 2000 : 235).

1940's – 1950's

"Luanda was a (un)predictable colonial city, characterised by an increasing social exclusion, fuelled by a search for a better life and the proliferation of its musekes. The constructions were spontaneous and self-built, located in or around the asphalt town (NETO, 2000 : 42).

[6] Concept later elaborated on Chapter 2.
[7] An authoritarian and corporatist Portuguese regime ruled mainly by Prime Minister *Oliveira Salazar*.
[8] The *International Style* that shaped the reconstruction of European cities in the wake of the Second World War.

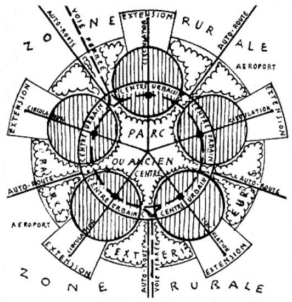
The *Luanda's* Urban Plan of 1942, created by *Étienne Groer* and *David Moreira da Silva*, was highly influenced by the theory of Howard, *"The Garden City",* proposing the satellite cities strategy (MARTINS, 2001 : 265). According to *Martins* (2001 : 265) the model has a radial design, with poly-centric connections - which are used as the main input and output streams - from the city centre to the new peripheral cores. This composition intention is to flow the population from the centre, pulling them to outside centralities, and turning them consequently into dorm-cities.



F_008 The Luanda Masterplan of 1942 by Etienne Groer [s: FONTE, 2007]

"The urbanised city began a rapid expansion through tentacles that penetrate the various blocks of the slums who were forced to retire to increasing distances" (AMARAL, 1968 : 15).

The plan was the first idea of an urban draw, which at the time, limited the city, untying Europeans from Natives. Each satellite would shelter about 50,000 inhabitants, spread on a semicircle around the existing urban area and connected by a ring road, however the plan was rapidly outdated by the capital's fast growth (COSTA, 1984 : Plano para a Cidade Satélite nº3). The satellite city plan in *Luanda* flopped when the principal linear connections to the city centre failed to be functional.

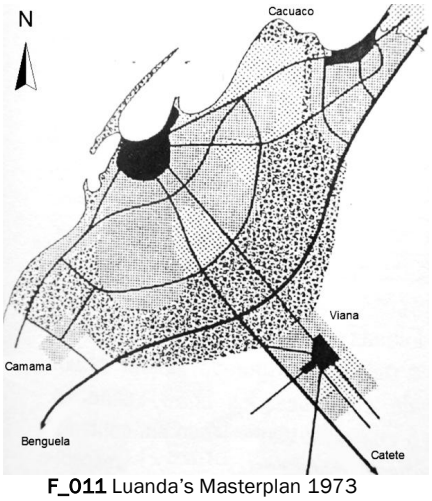


F_009 The Garden City Theoretical Model by Etienne Groer [s: FONTE, 2007]

1960's – 1970's

In 1961-1964 emerges a new attempt of controlling the demographic growth, the "*Plano Director de Expansão de Luanda*" by architect *Simões de Carvalho*, the proposal was a new approach to urbanism and in all sectors related to the growth of the city. Despite of not being later approved, it paved the way to future projects, such as "*Planos Parcelares de Unidades de Vizinhança*", with the objective of urban fabric cohesion. Which was a re-interpretation project based on the principles defined in the *Athens Letter* manifesto[9] (FIGUEIREDO, 2008 : 29). In 1971, the enterprise *Omnium Technique d'Aménagement* was contracted to develop a masterplan for Luanda. This plan proposed the creation of three alternative growing poles; *Viana, Cacuaco* and *Camama*, restricting the uncontrolled expansion (MARTINS, 2000 : 265). This solution interpreted as the necessity of containing the informal development, proposing its restoration, creating areas that would generate employment. However, the spatial and functional segregation maintained in favour of the colonisers, in structured urban areas, accumulating natives in less favoured areas peripherally (BETTENCOURT, 2011 : 73).

F_010 Schematic of European and Indigenous relations. [s: FONTE, 2007]



F_011 Luanda's Masterplan 1973 [s: MARTINS, 2013]

[9] Urbanist manifesto resultant from the IV International Congress of Modern Architecture (CIAM), promoting the separation of habitation, health and recreation sectors.

POST-COLONIAL period amidst civil conflicts

1975

Angola acquired its independency in the 11th of November. The insufficient formal mechanisms of the urban fabric and the increasing flow of rural population to the city, encouraged a rapid expansion of the informal market, and Luanda faced an increase on its *musekes*. The Urbanisation and Housing Office of Luanda (1974-1977) did not manage to predict the growth of the city and failed to minimise the consequent increasing problems with peri-urban informal settlements (VIEGAS, 2012 : 8).

1980's

A new initiative of intervention was proposed by the *Development Workshop*, in 1987, to create a cabinet for rehabilitation of the informal neighbourhoods in Luanda. This office presented the PMDUS, which became a reference for the strategic development of social mobilisation and for the provision of basic urban services. Its application did not have the expected outcome, because of the sporadic augmentation of the housing search (BETTENCOURT, 2011 : 73).

1990's

Also according to the Development Workshop (2005), the difficult management of informal peri-urban settlements in Luanda also undermined the administration of the urbanised city. The public networks were saturated; sewerage, water and power supply systems were vandalised, public funds were being embezzled, green areas and existing infrastructure were being uncontrolled occupied. The decade of civil conflicts to come would worsen the scenario (VIEGAS, 2012 : 9-10).

POST-COLONIAL period amidst peace

2000's

In 2001, Angola had approximately 14 million inhabitants and 83.1 percent of the urban population lived in *musekes,* according to UN-Habitat. The end of the civil war in 2002, brought hope on a long-awaited future, and the chance to create a advanced social and urban structure. Nonetheless little was invested in a sustainable guidance between the society and the territory, and all innovative social programmes have been clearly insufficient.

"Nowadays, the current trends in the reshaping of the Luanda territory, show the irrational drive of the capitalist production, relying on interventions liable to generate more capital in short-term periods." (HARVEY, D. Spaces of Capital, Towards a Critical Geography, 2001)

2010's - Currently

In the formal city, the urban centre struggled to preserve its historical heritage from the XVII to the XX century. The majority of the modern tropical architecture is deteriorated due to lack of maintenance, and the remained buildings are still unfinished, occupied or '*musekizados'* [10] (BETTENCOURT, 2011). The early buildings [i.e. *Kinaxixe* Market] are replaced by towering constructions, luxury gated communities are also growing closed walls [mainly along the Bay or in the South stretch; i.e. *Talatona*]. According to the *Angola Official Gazette*[11] in 2011, the urban transformation was not motivated by any Master-Plan. Recently, new plans were integrated for the expansion of *Luanda-Bengo* that defined rules on land use (VIEGAS, 2012 : 11).

The Project "*Meu sonho, Minha Casa"* encouraged the construction of millions of homes for low-income families. However, the assigned projects were stablished to develop in micro-locations, far from the centre. The most recent strategy is the peripheral rehousing [i.e. *Zango*] done in order to accommodate the deprived population, living in central *musekes* [i.e. *Chicala*], decrepit buildings [i.e. "*Cuca*" building], and in critical or geologically unstable areas [i.e. *Luanda* Island] (VIEGAS, 2012 : 122).

F_012 Kilamba Neighbourhood.
[s: VERANGOLA]

The deficiencies in social services and urban infrastructures are increasing in these fast-growing peri-urban areas, tending to accentuate the centre-peripheral duality. The inhabitants of the more peripheral districts are penalised either by the greater distance to the centre or by the poor quality of access facilities (OPPENHEIMER & RAPOSO, 2007 : 109-117). In short, each Urbanisation Plan of Luanda, instead of integrating, it has caused the increased drag of *musekes* to the periphery. The PDPL (Provincial Development Plan of Luanda) is a document made in order to evaluate and organise approaches to solve urban issues of the capital. In the SWOT[12] analysis, distinguished the following weak points (PDPL, 2014 : 93);

- Creating a trend out of large social dis-inserted neighbourhoods in the urban network.
- Lack of *green areas* in the city of Luanda.
- Lack of decent infra-structural public spaces.
- Low level of mobility within *musekes.*
- Lack of *public discussion* on the most important urban issues of the Province.

According to the terms of reference defined by the PDPL, the theme "*Luanda 2030 – Cidade Inovadora*" is set to lift Luanda as a worldwide city. The integrated actions are foreseen as (PDPL, 2014 : 92);

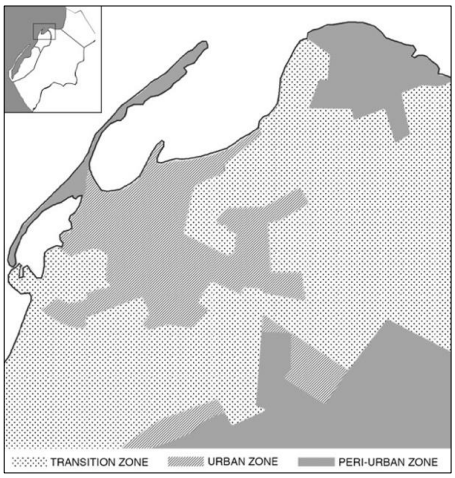
- Regeneration of *informal settlement* areas "slums" in order to re-new or refurbish.
- Fix the current *territorial mobility imbalances* in the urban fabric of settlements.
- Creation of new economic centres.
- Composition of environmental corridors.

[10] The term "musekização" is used to characterise the act of degradation of any urban space.
[11] SWOT is an acronym for *strengths*, *weaknesses*, *opportunities*, and *threats,* elements evaluated in a structured planning method.
[12] Official Bulletin of the General Government of the Province of Angola.

Currently in Luanda, the urban layout of the city, displays a planned regular centre, surrounded by organic *musekes,* and dispersed centralities. The country-side, desired by *Howard* in the *Three Magnets* theory, can never be achieved in this circumstance, since there is no vague space for afforestation, as the *musekes* define all the existing extension of the city.

As Martins (2001 : 266) declares, that *"Almost feels like, the expectation of improving musekes is lost, or not even taken in consideration.".*

1.3.2. DIVERSITY OF URBAN FABRIC ANALYSIS



F_013 Luanda's Zoning. [s: Author adapted from OPPENHEIMER, 2007]

The discriminatory nature of the colonial system determined for African cities a dual morphology for African cities, based on an urbanised nucleus - the "*Cidade Branca*" - surrounded by temporary unplanned bands in precarious conditions - the "*Cidade Negra"* (OPPENHEIMER & RAPOSO, 2007 : 67). According to Amado (2003 : 13), the Luanda's rhythmic development forms the *"emergence of two different entities - impending yet not integrated - characterise the peripheralization, resulting from the processes of densification of the urban centre and adjacent areas."* In his opinion, *"the peripheralization, specifically in Luanda, has a generating force dismissing the new low-income migrants to areas closer to the centre"*. This is due to the provision of improved urban infrastructure and social equipment - located in the centre - which will further reflect in the crystallisation of social inequalities (OPPENHEIMER & RAPOSO, 2007 : 52).

Luanda has been experiencing *"a diversified spatial distribution presenting denser areas than others, which have shaped the current urban duality of the city."* (AMADO, 2003). The centre grows vertically, but is less dense than the boundary which grows horizontally. The concerns that troubled the original *musekes*, nearest to the centre, are augmenting since these informal constructions are continuing to spread. *Musekes* vary in types, forms, size and location, subject to different land tenure, densely or sparsely occupied, with or without street patterns. Given that different contexts houses a variety of slum typologies, it is clear that there is not an international feature (UN-HABITAT, 2014 : 46). It's undeniable the understanding of *museke*'s exclusion, since its bodily characteristics drastically differs from the planned urban centre of Luanda (VIEGAS, 2012 : 7-8).

Recently, the Development Workshop (2005) classified a series of these settlements, however we will briefly focus on; *township settlements* ***(1),*** *organised musekes* ***(2),*** and *old musekes* ***(3).***

TOWNSHIP SETTLEMENTS [i.e. *Kilamba Kiaxi, Panguila* and *Zango*] post-civil war urban plans developed by the Government, residential areas at a large-scale, located near the urban centre with low level of infrastructures and services.

F_014 Panguila, Location, Map and Morphology Diagram. [s: Author adapted from GOOGLE EARTH]

The plan consists of regular streets and houses layouts. These groups are concentrated in the limits of the new urban expansion of the city of Luanda. In contrary to posterior social housing programs, these are focused in vertical constructions, in order to accommodate more families, since the growth of the city has been escalating throughout the years (BETTENCOURT, 2011 : 62).

F_015 Zango. **F_016** Kilamba. Location, Map and Morphology Diagram [s: Author adapted from GOOGLE EARTH]

During the 20th century, zoning regulations (in the developed world) and rapid demography growth (in the developing world) have caused the separation of the places where citizens work from the districts in which they live. This results in people travelling great distances on a daily basis, as verified in the Luanda township settlements (A GREEN VITRUVIUS, 2001 : 50). In addition, the neighbourhood plans, revealed several deficiencies, as the alleged affordable apartments for the population, was rebuffed by the price of an apartment, which is out of reach for the common Angolan (KRIEGER, 2012).

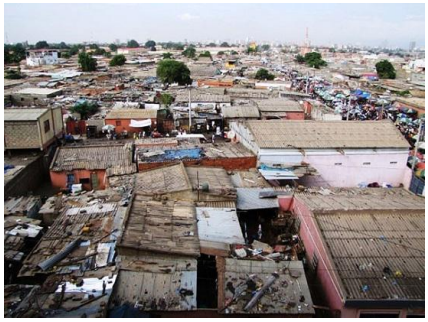
F_017 Zango Neighbourhood
[s: WIKIMAPIA]

OLD MUSEKES [i.e. *Sambizanga; Cacuaco, Viana, Camama*] residential areas [currently mega-scale] sometimes blended with the formal city - miscegenation[13] - or expanded into areas of geological risk.

F_018 Sambizanga. **F_019** Viana. Location, Map and Morphology Diagram [s: Author adapted from GOOGLE EARTH]

F_020 Old Museke in the Periphery
[s: Angola Bela]

Despite the old *musekes* proximity to the centre, the mobility between both realities is difficult, due to the dissimilarity of the urban patterns – centre [orthogonal] and *musekes* [organic]. There is also a lack of infrastructures or services, consisting of streets with no draining system and unable to allow access from transports to the precarious houses built with sticks, or wood (BETTENCOURT, 2011 : 67). Graphically, this case would be easily recognisable through its irregular patterns and unplanned occupation, higher mass-to-void relationships [higher densities], with very small corridors and pathways that foretell the limited possibilities for land legality services provision, circulation and public spaces (UN-HABITAT, 2014 : 15).



F_021 Bairro Operário
[s: Angola Bela]

ORGANISED MUSEKES [i.e. *Cazenga, Bairro Operário*] social housing programs firstly developed in the colonial period, were residential areas are usually built as an extension of the formal city or even township settlements.

These *musekes* consists mainly of reticular streets, houses built with bricks or cement blocks, and tin and fibre-cement roofing. This plan also presented deficiencies concerning foundation infrastructures or services. Even though these habitational groups were more organised than the organic *musekes*, the lack of social and economic structure, deprived communities, affecting their homes (BETTENCOURT, 2011 : 66).

[13] Is the process of genetic admixture. The term is normally used as a bad connotation, and is used here to define the characteristics of a slum that grew for centuries alongside the centre, mixing constantly.

F_022 Cazenga **F_023** Bairro Operário. Location, Map and Morphology Diagram [s: Author adapted from GOOGLE EARTH]

As organized *musekes* presents a much more predictable pattern of land occupation, with noticeable signs of urban layout planning, these constructions should outlive potential threats of eviction. This case makes for an easier provision of infrastructure in the future, particularly because of its defined street pattern. Despite having to face difficulties in upgrading, these slums may also become consolidated neighbourhoods with access to streets, services and public spaces over time (UN-HABITAT, 2014 : 15).

1.3.3. MOBILITY

Car-oriented planning, loss of public space and lack of human scale are blamed as the main causes of the overall loss of urban quality (RUANO, 1999 : 18). Density and transportation systems are closely interdependent. In a world where dispersed settlements patterns are encouraged, this requires people to make many journeys and use public transportation (A GREEN VITRUVIUS, 2001 : 51). Car-oriented town planning is not sustainable, cars produce congestion and pollution, thus leading to health problems and economic losses, since much valuable time is lost in traffic. This process have colonised the public realm, depriving open space of human scale and effectively dehumanising entire communities. Forward-looking planning encourages transport-conscious strategies, that consists that the daily activities are at reach of walking or bicycle distance (RUANO, 199 : 13).

According to UN-HABITAT, *"mobility is a key dynamic of urbanisation since the spatial imprint - defined by roads, transport systems, spaces, and buildings - shapes cities."*.

Various countries in the developing world face issues with distances between functional destinations leading to a growing dependency on transport. In African cities the low-density horizontal urban development causes further exclusion of the less privileged. Due to poverty, many residents cannot afford to travel to the city centres, depriving them of benefits (UN-HABITAT, Mobility : online sc).

"There was a decline in the formal supply of road transport and this provided the opportunity for the emerging Luanda's minibus taxi [candongueiro] industry." (LOPES, C. M., 2007 : 9).

In Luanda, the lack of institutional coordination, urban planning, financial resources allocated to investment and maintenance, are major factors which has resulted in poor condition of the roads (LOPES, C. M., 2007 : 11). Furthermore, mobility should be more than a matter of developing transport infrastructure. It has to include city planning as a whole, to overcome the social, economic, political, and physical constraints. Understanding that the purpose of mobility is to gain access to destinations, (UN-HABITAT, Mobility : online sc) transport junctions need to be established thus facilitating access to an extending range of public transportation system, on both macro level – the city and beyond – and micro level – the neighbourhood. One such project is called "*Promoting Sustainable Transport Solutions for East African Cities*," which aims to reduce private vehicle growth, thus reducing traffic congestion and greenhouse gas emissions in three East African capitals: *Addis Ababa, Kampala*, and *Nairobi*. The reduction of greenhouse gas emissions shall be achieved directly through sustainable infrastructure and clean fuel use, and indirectly through the development of local management capacities and knowledge on urban mobility (LOPES, C. M., 2007 : 32).

1.3.4. TENURE LAWS

Land tenure is the right of an individual or group to occupy or use a piece of land. Inner cities complex mobility can result in illegal constructions in order to remain in urban centres. People who are safe from eviction have a sense of long-term stability—whether they own the land or not—are much more likely to invest in their housing or community. Over time, these incremental improvements by residents can upgrade the entire community. Often, slum dwellers face obstacles, since land markets are frequently dysfunctional, and inappropriate regulations make it nearly impossible for local authorities to find enough land for the overcrowded slum settlements. In addition, control of land is often connected to political patronage and corruption, making it difficult to get clear information about land ownership, use and availability. (CITIES ALLIANCE : online source)

The current legislation in Angola is generally based in the colonial legal system, with a few post-independence adjustments (BETTENCOURT, 2011 : 70):

1975

The new constitution established that all land belonged to the Government, and its use may be transferred to individuals or entities.

1994

The law '*Resolução 30/94'* was approved by the Provincial Government of Luanda to control the use of tendency of unplanned land usage.

2000

The Management Plan and Urban Growth of Luanda was approved by the Council of Ministers, which would serve as the foundation for a forthcoming master plan.

2002

After the end of Civil War, the Council of Ministers appointed a new Commission to arrange a new Land Law. This fresh land law "*Lei No. 9/04*" approved by the President on the 9th of November, states that the land is owned by the State and that its use may be transmitted legally to singular or collective people. However, the usual route of land access and housing in Luanda is through informal transactions. In addition to traditional acquisition by purchase or lease, there are other cases of informal land access by inheritance or simply informal occupation. The studies matured by *Development Workshop,* indicate that the informal purchases for access are most common in peripheral slums. The vast majority of the population has no understanding of the rights and legal documentation that is intrinsic to access land properties. Another Development Workshop research-action program "*Access to Land in Peri-Urban Areas of Angola*", shows that 80% of surveyed residents admit to have the evidence of land purchase and only 16% admitted to absence of documents. However, only between 10% and 25% were recognised by the local administration, which means less than 20% of the population surveyed had legal formal documents in their possession (BETTENCOURT, 2011 : 70).

Regarding the land tenure security, it can be concluded that much of the population has access to it, through informal mechanisms, but feel relatively safe with that possession (BETTENCOURT, 2011 : 72). In Luanda, during the first two years of independence, the Ministry of Public Works and Housing, continued the work of the Angolan Housing Bureau in 1974, and carried out the inventory of the *musekes* and the preparation of proposals for reorganisation or subdivision. The two types of plans applied in the first years of independence to the peri-urban neighbourhoods acquiring new configurations: plans of re-ordering and improvement of the existing districts (assigning titles of occupation); and plans for new peripheral settlements (OPPENHEIMER & RAPOSO, 2007 : 223-238).

The World Bank and UN-HABITAT have been at the forefront in promoting the security of tenure approach. In particular, UN-HABITAT in 1999, adopted the Global Campaign for Secure Tenure as an advocacy instrument designed to promote secure forms of tenure for the poorest segments of the population, especially those residing in slums and informal settlements. The Campaign encourages negotiation as an alternative to forced eviction, and the establishment of innovative systems of tenure that minimize bureaucratic lags and the displacement of the urban class. It went about doing this by first, addresses the problem of tenure insecurity in slums, which otherwise would translate into a vicious circle of construction, demolition, eviction and reconstruction. Second, it encouraged the provision of urban services that were previously absent. Third, secured tenure that motivates residents to invest and contribute to the management of their built environment. Fourth, tenure security could in principle contributed to the financial base and resources of local governments by improving tax recovery on both property and economic activities. Finally, from a political perspective, tenure regularisation could be seen a means of ensuring social cohesion and stability in cities (ARIMAH, 2011 : 8).

Nigeria Promoted Alternatives to Forced Evictions in Port Harcourt. Following a request of the Local Government, UN-HABITAT undertook a fact-finding mission in Port Harcourt on March 2009. The main problem was the inadequate implementation of legal provisions in the Rivers State's Physical Planning and Development *Law of 2003*, which makes most of the evictions illegal, since the institutions and mechanisms prescribed for urban renewal were not in place. UN-HABITAT in its report to the Rivers States Government recommended actions for more sustainable and rights-based urban development. These included:

- A **moratorium** on evictions.
- A consultation mechanism for all stakeholders to participate in the city's development, including **settlement upgrading**, not based on *forced eviction*.
- Design of **public-private partnerships** for *real estate development* that benefits the urban poor and does not destroy entire neighbourhoods or the livelihoods of residents.

So far the Rivers States Government has yet to implement any of UN-HABITAT's recommendations (UN-HABITAT, 2015, Practices and Perspectives : 25).

F_024 Catambor. [s: instagram, @dani_brandani]

1.4. MUSEKE, THE ANGOLAN SLUM

1.4.1. MUSEKE'S PROBLEMATIC

MUSEKE is an indigenous Angolan based language for **SLUM.**

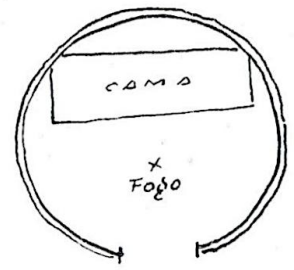
In *"The Challenge of Slum-Global Report on Urban Settlements" (2003)*, UN-HABITAT defines *"slum" as "a wide range of low-income settlements and/or poor human living conditions.".*

museke [*kimbundo*] is the name given to the reddish argillaceous sand embodied in Luanda. This is in referenced to the boundaries of the city, for not having paved streets, as referred by the writer *Pepetela* on his "*Luandando*" book.

"The museke is closed in a complex interlacing and organic alleys, small squares and corridors. The streets are as narrow as passing spaces with a persons width. Unaware of any planning, responding solely to pedestrian access needs, to the most recondite places in the museke's heart. The chaotic configuration, favoured the formation of a place with identity and charisma." (QUELHAS, 2006).

Sanzala is the name given to rural clusters of houses in Angola. Its organic formulation is the way its inhabitants considered being the culmination of living in society. The clusters that form the *sanzala* are Cubatas; which is constructions of narrow wooden sticks structure, covered by adobe and clay (FONTE, 2007 : 13).

F_025 Cubata Plan. [s: FONTE, 2007]
F_026 Cubata. [s: ALEXANDRE, 2016]



The phenomenon of rural migration, due to the civil war, led the population to carry the only constructive and urban knowledge they had - *cubatas* and *sanzalas*. In association with the lack of economic capacity, it's proper to understand how musekes developed. "*In the slums of Luanda is possible to find references to sanzalas, the cubatas are arranged as a group in the territory, forming a unit with a patio space facing the housing."* (FONTE, 2007 : 14).

DESTRUCTION | **RE**CONSTRUCTION

Slums have been portrayed as institutional failures in housing policy, public utilities, local governance and secure tenure. Over the past five decades, authorities in African countries have adopted several strategies to tackle the problem of informal settlements. These approaches include; neglect, forced eviction and demolition, resettlement or relocation, slum upgrading programs, and most recently, the adoption of enabling strategies (ARIMAH, 2011 : 4).

Forced eviction is the term which describes what happens when people are removed from their homes and communities against their will – often without provisions to resettle them somewhere else (UN-HABITAT, 2005 : 16-17).

"Since 2008 there have been destroyed more homes than built in Angola. Thousands of people have been displaced across the country, mainly in the provinces of Luanda, Huíla and Benguela, where it was found, catastrophically, the destruction of thousands of homes." (ARIMAH, 2011 : 6).

In this context, arises the Campaign "*Não Partam A Minha Casa"*, in 2010, developed by OMUNGA[14]. This campaign aims to promote the respect, protection and realisation of the right to adequate housing. Initially centred in the cities of *Lobito* and *Benguela*, creating material, methodological models and best practices for the protection of this right (JIMBI, 2011 : v3 p182-184).

F_027 Project against illegal evictions.
[s: OMUNGA, 2010]

The houses built under the social housing projects have a minimum value and benefits only a few high-income families thereby neglecting most. The promise to resettle families with dignity was not met, causing the displacement of these families to another *museke*.

"The musekes mark an irreversible transition in the urbanisation process. Several studies show that the slum-dweller just moves to another slum or an urbanised space, rarely returning to the life on the field." (BETTENCOURT, 2011 : 53).

So what's the true value of *musekes*?

[14] OMUNGA is an Angolan Civil Society Association that promotes actions in favour of human and cultural rights.

According to UN-HABITAT (2003 : 9) report, "The Challenge of Slums", slums can be divided into two broad classes:

1 *Slums of hope*: 'progressing' settlements, which are characterised by new, normally self-built structures, usually illegal that are in a process of consolidation and improvement.

2 *Slums of despair*: 'declining' neighbourhoods, in which environmental conditions and domestic services are undergoing a process of degeneration.

John Turner worked on a series of upgrading programs largely funded by the World Bank. Turner had argued based on field observation, that demolition was not the solution for slums. If governments could improve the sanitary conditions and environmental quality of slums, then residents would gradually improve their houses, especially when secured by tenure laws (ARIMAH, 2011 : 6). Second to that, the attitude of Angolan authorities should be clear, if there is not a preferable solution than relocating, *musekes* should be transformed in order to create a better place to live. Historically, *musekes* represent a cultural treasure, since they are part of the way Angolan society engage. Indeed there are options alongside rehabilitation and recycling, which can save frustration, avoid a larger exclusion, and esteem the majority of the people of *Luanda* that lives in informal settlements.

1.4.2. SANITATION AND WASTE DISPOSAL

F_028 Streets of Bairro Operário. [instagram: @notflavio]

F_029 Garbage blocking the streets. [s: ANGOP]

The health of the population is another element of human development and is a necessary condition for economic growth. After the independence of Angola, all sanitation infrastructures - existing in the colonial period - crashed due to poor maintenance. On the other hand, the constructions made after independence do not have the guidance of qualified employees, so the drainage system drains into lower zones, which are usually water courses - sea, rivers, streams and lakes - aggravating pollution. According to MINEA (Ministry of Energy and Water), the network coverage in urban areas is estimated to suffice 74.1% of the population, 18.5% of which are connected to suitable networks, and the remaining 55.6% use toilets or empty wells (MINUA : c4 p13).

"People living in slums experience miserable environmental conditions, which are the inadequate water supply, sanitation conditions, breakdown of waste disposal arrangements, which defines the population vulnerability to serious health risks." (ARIMAH, 2011 : 2).

In terms of the performance of the garbage collection system, there is an inability of the operators to satisfy current necessities. Thus, the degree of effective coverage of services at the level of Luanda, lies in the fact that the operations are focused in places with easy access automatically excludes *musekes* (MINUA : c4 p60). The access to water and energy networks, level of sanitation and drainage, dumps, etc. indicates the index of urbanity, and the most affected areas are the most peripheral and far from the urban centre (OPPENHEIMER & RAPOSO, 2007 : 118). In order to tackle this issue it is necessary to reform the Government faulty system, and develop awareness about avoidable waste and sustainable resources, such as recycling.

1.4.3. QUALITY OF LIFE

Quality of life as defined by the *Business Dictionary* is *"daily living enhanced by wholesome food and clean air and water. The enjoyment of unfettered open spaces and bodies of water. Conservation of wildlife and natural resources, security from crime, and protection from radiation and toxic substances."*

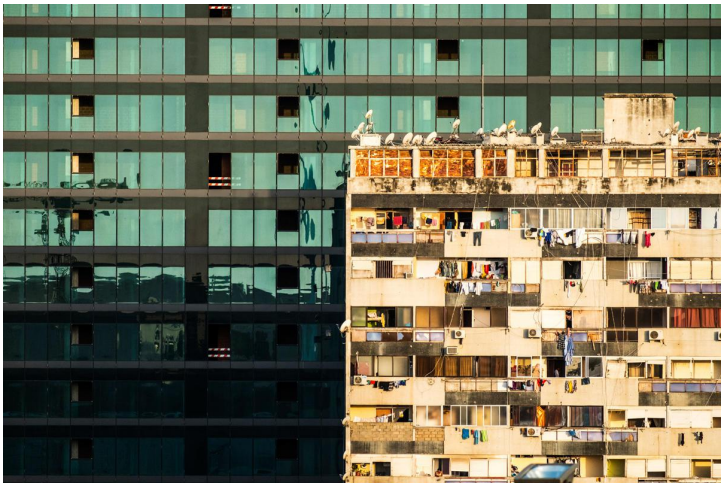
"Cities are the predominant mode of living, and the city's growth is related to the expansion of areas that have concentrated disadvantages. In the developing world, where most of the global urbanisation is to be observed, a large segment of that growth is into slums." (OOI G, 2007 : 3). People living in informal settlements experience the most deplorable living and environmental conditions. They are also excluded from participating in the economic social, political and cultural spheres of the city (ARIMAH, 2011 : 1). Slums arise from the poor masses' need to find affordable and accessible housing. They are created by the market or by the people themselves when increasing numbers of people in poverty meet inadequate housing and planning responses (UN-HABITAT, 2003 : 3).

Inequality is visible on. It frustrates economic growth to have an effect on poverty. It is directly associated with slum formation and dilapidation in cities exposed to global trade (UN-HABITAT, 2003 : 3).

According to UN-HABITAT in "*The Challenge of Slums—Global Report on Human Settlements"* (2003), people living in *musekes* can not achieve the designed quality of life if every slum household lacks one or more of the following five amenities:

- Durable housing
- Sufficient living area
- Access to improved water
- Access to improved sanitation
- Secure tenure

Nevertheless, it is achievable to rely on *Upgrading Programmes,* which are locality-based improvement strategies designed to replace the various degrees of obsolescence and decay in slum areas (ARIMAH, 2011 : 9).



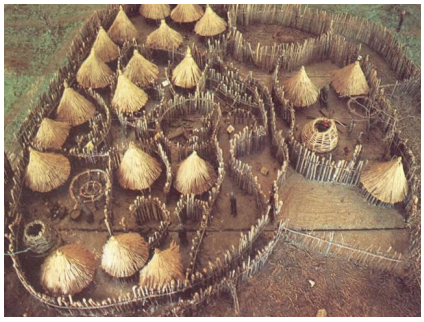
F_030 Buildings contrast in Luanda. [s: Notícias Magazine]

1.4.4. THE EVOLUTION OF THE ANGOLAN HOUSING

"To dwell is to make one's adobe: to live in, or at, or on, or about a place. Dwelling is both process and artefact: it is the experience of living at a specific location and it is the physical expression of doing so." (OLIVER, 2003 : 15).

The culture and people's way of living determine the nature of constructions. In Angola, one can easily distinguish a dwelling with ephemeral characteristics, which mainly served the nomadic people, from the solid dwellings of sedentary people. Angolan housing can be divided into two typological groups. The first refers to the constructions of nomadic tribes, as the *Boschimans*, where walls and ceiling constitute a single element. Due to the nature of their life, constant relocation, they have no emotional link to any location. The second group required more construction time, only using blocks of adobe, and the wall and ceiling represented two distinct bodies (MATEUS, 1934 : 2-4).

F_031 M'Banza Aglomerate XIX Century. [MEDINA, 1996 : 98]



F_032 Sanzala. [s: Angola Bela]

According to *Redinha*, the earliest native dwelling is, the *cubata* (*cit in* REDINHA, 1964: 17). Angola was divided by two urban agglomerates categories; *M'Banza* and *Sanzala*. *M'Banza* is essentially constituted by c*ubatas* and a political and administrative centre, which houses the nobility. In the western model, the *M'Banza* would be classified as a town. The *Sanzala*, on the other hand, is a cluster of small-scale *cubatas*. According to western models, would be considered a village, with an inbred social structure and leadership of a power figure, *Soba* (THISSEN, 1966 : 87-91). Morphologically, both urban aggregates are arranged irregularly, without implantation or quantity rigor. In former times, the *cubatas* were arranged in a circular pattern around the *Soba*'s house, recently they are fixed linearly on the roadside (FERRAZ, 2005 : 45).

Until 1964, the publication year of his book, *José Redinha* (1964 : 7-48) describes four main evolution phases of the traditional Angolan house. In the Primary Phase, the house presented two different forms; the first was the circular-shaped dwelling with *"conical"* elevations and second is the square-shaped dwelling, which could include the round and tetragonal cover. The materials used were plant species such as; *"reeds, wooden sticks, trunks and folding - papyrus - bordello - vegetable fibres - plasters of mud and ox manure".* The Second Evolution Phase is characterised by the advancement of rectangular forms and the introduction of internal compartments. Later emerges the distinction of the building body, roofing, balconies, elevated platform and decoration. There is also the introduction of constructive elements, doors, door jambs and mortar finishing work. The Modern Phase is marked by the introduction of western standards, which results in acculturation, encouraging the abandonment of ethnic constructions. The structures improved and defined a greater variation of dwelling plans. As far as materiality is concerned, the zinc sheet is used as a covering element, and the whitening technique, for walls. At this stage, arises the first definition of the general base model for the Angolan suburban construction. Determined by a patio area next to the house, and inside, an entrance hall with two bedrooms.

Finally, we come to the fourth which is the Current Phase (in the 60's) which is the consolidation between the values of Angolan vernacular and western architecture. The acculturation led to appearance concerns, suggesting the painting of both interior and exterior walls. It also led to the redefinition of constructive means, floors levelling, and the use of conventional materials such as zinc plates, tiles, masonry and cement. There is a paradigm completing the transition from the idea of housing, as a temporary element - as was the native *cubata* - moving to the idea of housing as private and unitary. The evolution of the Portuguese urban fabric over the territory ended up swallowing many sanzalas, forcing them to move to the periphery of the city, the designated *musekes*. The early *musekes* in the *Coqueiros, Bungo, Ingombotas and Maianga*, were inhabited by free African slaves. Throughout the 20th century, *musekes* were growing, becoming denser, more irregular and less cohesive (FERRAZ, 2005 : 45).

F_033 Downtown Luanda XX century
[s: ALEXANDRE,2016]

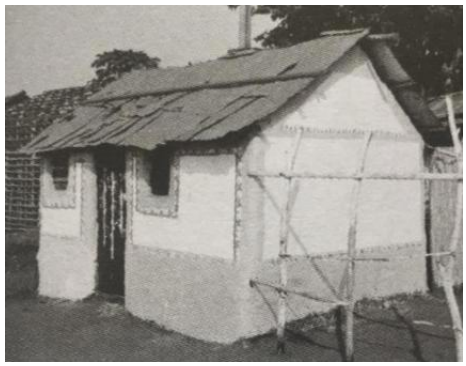
The history of colonial architecture, in Angola, are directly linked to the Portuguese occupation. The colonial architecture practiced in Luanda, come from a Baroque lineage, simplified during the XVII century, disregarding previous set ornamentation. Although the debugging of the buildings, a noble appearance is maintained, given their geometry, dimensions, finish and materials intact. There were two types of dwellings, the more modest single-storey dwelling that developed on a single ground floor and the "*sobrado*" house, with two or more floors. As for materiality, they were built with local soft stone masonry, wooden beams, a four-roofed cover, lintels in brick and pavement with clay tiles. In the townhouse case, the ground floor was generally for commercial purposes or warehouses, and the premises intended for workers. While the master's residence was in the buildings upper floor. In the single-storey dwelling case, it generally had three compartments and the courtyard (BATALHA, 2006 : 50-56).

F_034 Colonial Construction
[s: ALEXANDRE,2016]

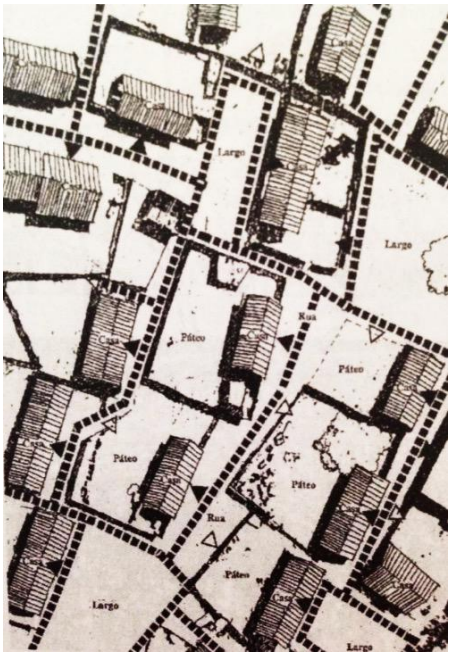
F_035 Indigenous "Pau-a-Pique" Structure.
[VeSoBue]

"Pau-a-Pique" Housing *in Musekes, Luanda*

The study carried out up to the 1960's by *Redinha* (1964 : 21-33) reveals constructions with indigenous influence. Projected with a rectangular plan, the construction of the walls were of towed pike and zinc plates covered rooftops. They develop at ground level, which was not paved, despite rare cases of cement pavement. The backyards were usually surrounded by boards, zinc sheets, tree trunks, and in some cases *luando* mats. As for the internal structure, they maintained the genesis of traditional architecture, a very simple division, generally with two or three compartments. Although due to the ethnic plurality in *musekes*, the dwellings would go up to ten compartments. The backyard was the centre of the active life in dwellings, where the kitchen and sanitary facilities were located.



F_36 Regular "Pau-a-Pique" Structure.
[ALEXANDRE,2016]



F_037 Patio Display Areas. [FONTE, 2007]

Although all of the social transformations that the population of Luanda was subjected to, which changed its "*modus vivendi*", it is clear to observe that several ancestral values are still preserved and applied in the dwellings in popular neighbourhoods like *Bairro Operário*. The most obvious is the outdoor space, as the central space of daily household life. This came to reaffirm the importance of the patio model as the most adequate type housing for the Luanda population (ALEXANDRE, 2016 : 77).

Currently the *musekes* represent about 80% of the urban network of the city of Luanda and are home to most of the population.

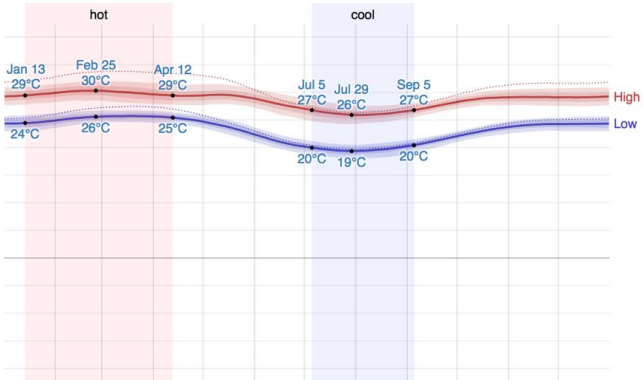
This self-construction is current resort, 45% of the buildings, although the quality of these constructions varies, 60% of the dwellings are built with improper materials. Most of the constructions carry an evolutionary process, so the house expands according to economic conditions. Note that this ongoing nature leads dwellings to advance over public spaces, worsening the already structural problems that *musekes* present (PDGML, 2015 : 68-69).

02. SUSTAINABLE MODULAR SOLUTIONS

2.1. BIOCLIMATIC DESIGN

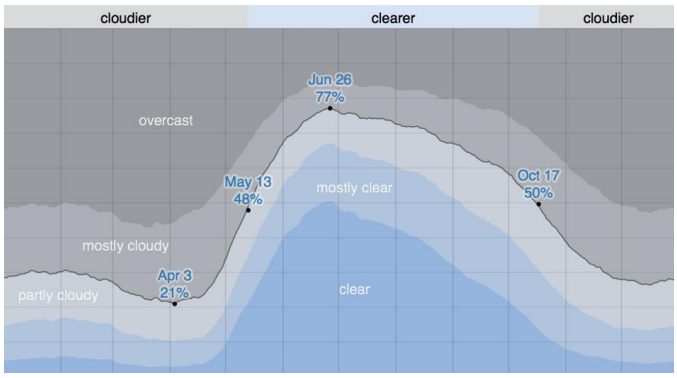
2.1.1. CLIMATIC CONTEXT IN LUANDA

Location: Southwest coast of Africa bathed by the Atlantic Ocean in the West.
The Angolan climate is classified as sub-tropical, hot and humid in most of the territory, with a semi-arid and dry sub-humid zone in the south and on the coastal strip up to the Province of Luanda (GUEDES, 2012 : 13). The hot season lasts for three months, from January 13 to April 12, with an average daily high temperature above 29° Celsius. The cool season lasts for two months, from July 5 to September 5, with an average daily high temperature below 27° *Celsius* (WHEATHERSPARK, 2016).



G_03 Average High and Low Temperature.
[s: WHEATHERSPARK, 2016]

The climatic context in Luanda demands prudence regarding the radiation levels. Since the year in Luanda is warm all-around, it is necessary to use shading systems and natural ventilation.



G_04 Cloud Cover Categories.
[s: WHEATHERSPARK, 2016]

The clearer sky part of the year in Luanda begins around May 13th and lasts for 5.1 months, ending around October 17th. The cloudier part of the year begins around October 17th and lasts for 6.9 months, ending around May 13th. The wetter season lasts 6.4 months, the drier 5.6 months. The predominant average hourly wind direction in *Luanda* varies throughout the year. The wind is most often from the south, lasting for 5.4 months, and from the west for 6.6 months. Following these characteristics it is possible to build in the lines of tropical architecture and passive design in Luanda, exploring the climatic features (WHEATHERSPARK, 2016).

2.1.2. PASSIVE DESIGN STRATEGIES

"Buildings designated for sustainability are built to minimise any negative impacts on occupants and the environment." (PLAINIOTIS, 2006 : 31).

The issues of sustainability and climate change are frequently linked to developed countries. However, as sustainability is also a consequent reaction to industrialisation and misuse of fossil based technology, it is important for developing countries to avoid the same errors (GUEDES, 2014 : 422). In developing countries, if future energy demands are to be sustainable and affordable, alternative approaches that promotes energy efficiency need to be embraced (KOCH-NIELSEN, 2002 : 13).

"The term 'active design' is understood as developing design solutions that exploit passive measures to achieve the desired indoor and outdoor comfort conditions. This is contrary to notions of passive design, where internal comfort is achieved primarily trough actives measures." (*cit in John Berry*, KOCH-NIELSEN, 2002 : 14).

With the variety of climatic contexts existing in Africa, it is possible to achieve a balance between building and climate. Active measures involve mechanical equipment, controlling the internal conditions regardless of daily or seasonal variations in the external climate. The disadvantage of such system is the high running costs and the fossil fuel energy consumption. On the other hand, Passive measures rely on utilising the elements inherent in a region's climate and its natural energy sources, reacting to seasonal changes, accepting the dynamics of the nature (KOCH-NIELSEN, 2002 : 15). Passive measures reduce the energy consumption of buildings throughout their existence. Two examples of passive strategies are the optimisation of the use of natural lightning to reduce the need for artificial lightning systems, and the promotion of natural ventilation to avoid the use of air conditioning for cooling (GUEDES, 2014 : 426).

2.4.2.1. APECTS OF TROPICAL PASSIVE HOUSE DESIGN

METEREOLOGICAL ELEMENTS

To adopt passive measures is to rely on climate conditions. According to *Holger Koch-Nielsen* (2002 : 21-51), passive design acknowledges four climatic features, that can be used in order to achieve the thermal satisfaction, in tropical areas likewise Luanda;

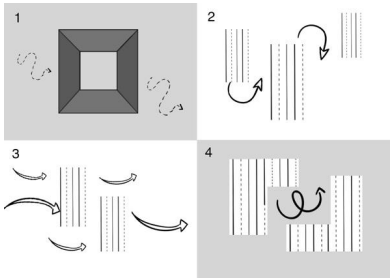
- **Radiation** is the intensity of solar radiation experienced by an area, and is affected by the length of day, angle of sun rays, distance from the sun, cloud coverage and quality of the atmosphere.
- **Air Temperature** is the degree of heating and cooling of the surface of the earth.

- **Wind** direction, speed, gustiness and frequency are the most important characteristics of wind. Depending on the origin the wind can be dry or humid, clean or dusty, hot or cool. In West Africa in the winter, hot dusty winds are from the North-East, and in the summer humid winds are from the South-West.
- **Orientation** of urban forms must be based on their interaction with the sun and the prevailing winds. The solar orientation of a building determines the intensity of solar radiation and wind orientation in order to maximise natural ventilation. A building's ability to store or release heat is related to its volume, whereas the rate at which it will gain or lose heat is related to its surface area. The space between individual buildings and road widths will have an effect on the amount of solar radiation onto buildings and on the air movement around and between buildings.

The urban design objectives for the climatic characteristics of Luanda are;
The house layout when laid out in a grid, spacing of six times a building's height will ensure air movement (KOCH-NIELSEN, 2002 : 120). In regions where overheating is a priority issue, a southerly orientation to the north is recommended. The use of porches should also be considered in order to prevent direct solar radiation falling directly on the external walls. The bedrooms when oriented to the east have cooler spaces, due to indirect solar exposure. The kitchen space which should be the coolest in the house, cannot be oriented north. Planting near the façades, or even cladding façades with vegetation elements, increases internal comfort, and acts as a filter for solar rays (GUEDES, 2014 : 440).

SEMI-ARID AND HUMID TROPICAL ZONES
1. Use of courtyard layout.
2. Buildings should be widely spaced to maximise the potential of air movement.
3. Buildings should be oriented perpendicular to prevailing wind directions.
4. Incorporation of street planting and green patios.

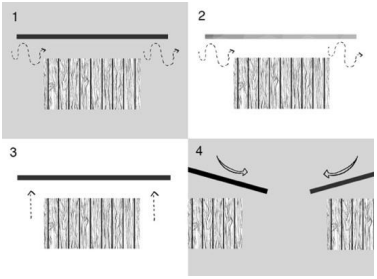
T_01 Building Orientation Options for Luanda. [KOCH-NIELSEN]



F_038 Orientation Illustration. [Author]

The courtyard model is an ideal option for a tropical construction, which comprises of a group of buildings or building elements surrounding an internal space that is open to the sky. During the day the courtyard space improves circulation movements and during the night collects cool air flowing down the roof. Another virtue of the courtyard model is that cooling breeze are normally available regardless of wind directions. Plants and trees outside the building play a vital role when the wind is forced to pass through them, thus allowing winds to be cooled and relieved of much of their sand and dust (KOCH-NIELSEN, 2002 : 57-58). Following those lines, the semi-arid and sub-humid climatic context of Luanda was associated with essential design options.

Roof Design The most important building envelope component is the roof, because of the greatest solar radiation exposure, difficult to protect. Its performance will depend on its form and materials. When outdoor air temperatures are higher than indoor air temperatures, the outer surface of the roof absorbs radiation and heats up. A low parapet wall can be used to prevent the cool air flowing off the edge of the roof to unwanted areas. The flat roofs present an advantage of becoming functional places (i.e. terraces) (KOCH-NIELSEN, 2002 : 64-72).

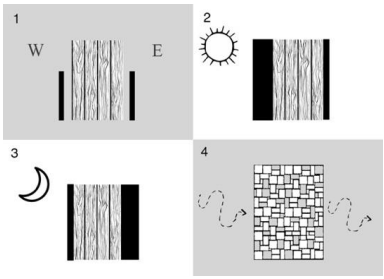


F_039 Roof Design Illustration. [Author]

ROOF DESIGN SEMI-ARID AND HUMID TROPICAL ZONES
1. The space around the roof structure should be ventilated to reduce the heat transfer. (i.e. openings in roof)
2. Roof made out of lightweight material.
3. Large roof overhangs to protect walls and openings from heat gains and rain.
4. Roof slopping towards a courtyard to cool internal spaces.

T_02 Roof Design Options. [KOCH-NIELSEN]

Wall Design Wall structures have several functions, besides being structural elements, they provide protection from heat, rain, wind, dust and light and also serve as space definition and partition (KOCH-NIELSEN, 2002 : 78-79).

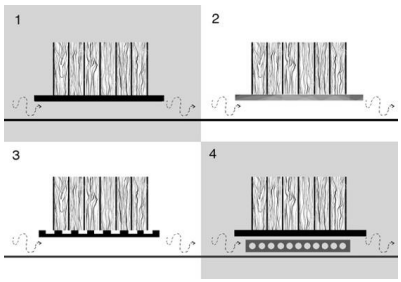


F_040 Wall Design Illustration. [Author]

WALL DESIGN SEMI-ARID AND HUMID TROPICAL ZONES
1. East and West facing walls should be minimised.
2. Walls of areas used during the day should be dense.
3. Walls of areas used during the night should be light-weighted.
4. Operable ventilation openings in walls.

T_03 Wall Design Options. [KOCH-NIELSEN]

Floor Design The ground floor of buildings can reduce heat gains by being designed to increase its overall thermal storage capacity – use of material with low absorptivity qualities [topic discussed further in chapter 4.2.3] - and overall ventilation potential. In areas when a building cannot cool down enough during the night, the floor can be elevated off the ground to allow the cooling effects. Also advantageous in reducing contact during the rainy season and protection from termites (KOCH-NIELSEN, 2002 : 80-83).



F_041 Floor Design Illustration. [Author]

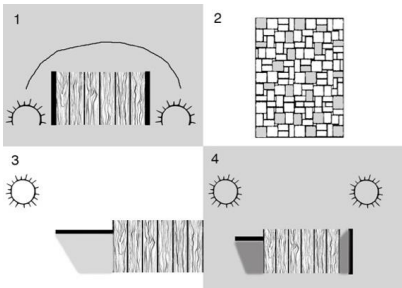
FLOOR DESIGN SEMI-ARID AND HUMID TROPICAL ZONES
1. Ground floor should not have contact with the floor, elevated about 50-60 cm.
2. Lightweight material for humid climates.
3. Provision of gaps between floorboards to improve ventilation.
4. If solid floor is needed, could have built-in ducts, such as hollow concrete slab, for semi-arid climates.

T_04 Floor Design Options. [KOCH-NIELSEN]

Opening Design link the internal environment directly to external conditions. During the day openings will admit solar radiation, which consists of direct or indirect sunlight required for lightning, avoiding artificial lightning systems through the day. They will also admit external air, required for ventilation purposes, which will facilitate the removal of internal heat gains from a building. The quality and quantity of air and light depends of the openings size, location and treatment. However, sophisticated solutions can combine several functions in a single opening (KOCH-NIELSEN, 2002 : 84-87).

OPENINGS DESIGN SEMI-ARID AND HUMID TROPICAL ZONES
1. Ground and horizon openings should be avoided in order to prevent glare.
2. Diffuse internal light can be achieved by screening.
3. Low overhanging roofs and wide verandas can be used to obstruct direct light.
4. Shading devices can be used to exclude unwanted radiation.

T_05 Opening Design Options. [KOCH-NIELSEN]

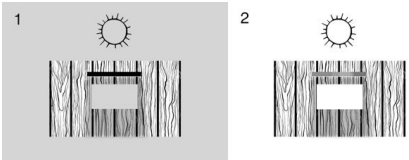


F_042 Opening Design Illustration. [Author]

Shading is a very effective strategy to reduce the penetration of solar radiation into the building, providing protection to areas of glazing and also to the opaque envelope. Which can be achieved by fixed or adjustable devices. The building should be especially protected from solar gains on windows oriented to the east and west, due to the low angle of the sun in the early morning and late afternoon (GUEDES, 2014 : 441-442). Among other features, such as reducing glare, protecting from the rain and influencing internal air movement patterns. The choice of shading devices should reflect both orientation and prevailing climatic conditions, represented in two forms (KOCH-NIELSEN, 2014 : 88-92);

1. Horizontal; best solution if the sun passes high in the sky across an opening, excluding solar radiation, effective for north- and south-facing openings.
2. Vertical; best solution if the sun passes low in the sky to shine into an opening, excluding solar radiation, effective for east- to west-facing openings.

SHADING METHODS SEMI-ARID AND HUMID TROPICAL ZONES
1. The device should be placed on the outside of an opening.
2. Device made from light and reflective materials to avoid absorption.
3. Design in order to prevent hot air trapped and reflection into the building.



T_06 Shading Design Options. [KOCH-NIELSEN]
F_043 Shadings Design Illustration. [Author]

Natural Ventilation and Cooling Methods in warm humid climates is the flow of air between the outside and the inside of the building. Natural ventilation originates from two natural forces: pressure differences created by the wind around the building – wind-driven ventilation and temperature differences – 'stack effect' ventilation. The distribution, size and shape of the openings are fundamental elements for achieving efficient ventilation.

The openings located in high positions allow high rates of ventilation for heat dissipation, and openings located on a lower level can provide air circulation (GUEDES, 2014 : 452) (KOCH-NIELSEN, 2014 : 87-117).

WIND-GENERATED VENTILATION	TEMPERATURE-GENERATED VENTILATION
SEMI-ARID AND HUMID TROPICAL ZONES	SEMI-ARID AND HUMID TROPICAL ZONES
1. Large openings wind ward causes lower air velocities compared to smaller openings.	1. Ventilation openings should address diurnal temperatures variations.
2. Green planting and envelope devices can be used in order to improve ventilation.	2. Ventilation openings in walls and roofs, to allow air to move over the warmest internal surfaces.
3. Continuous wind-generated ventilation addressing small temperatures differences.	3. Continuous vertical ventilation, generated through different temperature pressures.
4. Openings should be placed in opposing facades to facilitate cross ventilation.	4. In order to use the stack-effect, openings should be place at different heights

T_07 Types of Ventilation Systems. [KOCH-NIELSEN]

Natural ventilation systems, reduce, or can even eliminate the need for air conditioning, which largely contributes to energy consumption in warm countries, a consequent CO2 emissions. Also, in terms of air quality, in the book "*Healthy Buildings*", the authors, *Bill Holdsworth* and *Antony F. Stealey*, discussed on the internal air quality and material emissions that affect the ventilation needs. According to the report *"Less is More"* [15], *P. O. Fanger* notes that about 42% of the perceived pollution in a modern office building comes from the air-conditioning system and 20% from material emissions (KOCH-NIELSEN, 2014 : 119). Buildings that use passive cooling techniques can be comfortable, economic, energy efficient and environmentally friendly alternatives to air conditioned buildings (GUEDES, 2014 : 482).

2.2. 3S's BUILT EXAMPLES

For centuries architecture responded to social issues in a way that crafted solutions that improved the living space within cities. This sense of altruism is somewhat lost, in developing countries, since there is a lack of compromise in funding the slums crisis. Slums started to develop decades ago, but still remain a contemporary problem, even worsening because of the demography boom in urban areas. In order to solve this problem is necessary to embrace progressive ideologies and adapt them into the conception of new social housing programs. This chapter presents different building solutions that emboldens the concepts of the 3S's – Social, Sustainable and Standardised.

2.2.1. SOCIAL HOUSING SOLUTIONS

In "*Housing the Poor in African Cities; Low Income Housing, Approaches to Helping the Urban Poor Find Adequate Housing in African Cities*", UN-HABITAT defines approaches to low-income housing in improvement of physical, social and economic environment of an existing informal settlement, without displacing the people on-site. As well as improving infrastructure; houses, land tenure, income-generating opportunities, etc. *'When cities and governments support the process of upgrading informal communities, it is the least expensive, most humane way of enhancing a city's much-needed stock of affordable housing, instead of destroying it.'*.

[15] Produced by the Thermie Programme action by the European Commission Directorate-General for Energy.

2.2.1.1. QUINTA MONROY BY ELEMENTAL

Tarapacá, Chile [2003]

The first task was to find perspective to the problem, shifting the mindset from the scale of the best possible 7,500 [us] object to be multiplied 100 times, to the scale of the best possible 750,000 [us] building capable of accommodating 100 families and their expansions. Secondly, the provision a physical space for the "extensive family" to develop, has proved to be a key issue in the economical take off of a poor family. Third, due to the fact that 50% of each unit's volume, will eventually be self-built, the initial building must therefore provide a supporting framework, but also facilitate the expansion process. In the end, the decision was to build the half that a family individually will never be able to achieve on its own. Contributing to the process, in making it easier for common people to build their own destiny and finally overcoming poverty (ARCHDAILY, 2003).

F_044 Several Houses Grouped.
F_045 Houses Overtime. [ARCHDAILY, 2003]

2.2.1.2. RUCA DWELLINGS BY UNDURRAGA DEVÉS

Region Metropolitana, Chile [2011]

The design of this project was the result of participatory work between the community, the architect, and the sponsoring institutions. In these dialogues, which took place in a *ruka*, we were taught their history, traditions and worldview. The houses are grouped continuously on a horizontal level, thereby allowing the length of the main facade to face east. This provision, required by the ancestral tradition of opening the front door of the house toward the rising sun, was the primary requirement from the community. As a construction technique, the artisanal tradition of brick and reinforced concrete frame was used, expressing the correspondence between appearance and structural nature of the project (ARCHDAILY, 2011).

F_046 House view from the Street.
[ARCHDAILY, 2011]

F_047 House Ventilated Façade.
F_048 Interior Space. [ARCHITIZER, 2016]

2.2.1.3. CHACRAS POP UP PRODUCTIVE HOUSING BY NATURA FUTURA

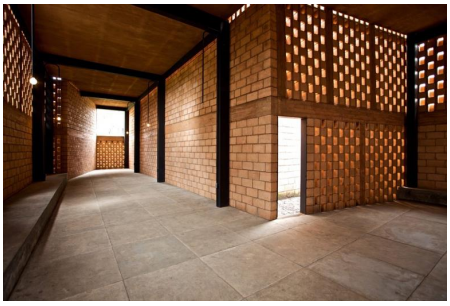
Arenillas, Ecuador [2016]

The housing is based on three bodies, two used for the bedroom and one for kitchen and living room, with progressive growth option. The distance of the house high terrain protects the structures of moisture while allowing a constant air flow under the floor. The altitude of the roof and the open spaces highlights more transparency of the windows, thereby allowing cross ventilation. The base of the house is concrete and bricks, being structured in modules based on the pallets of pine wood, used to carry a load of goods. The windows were constructed with wood semi-hard case and strips of recycled waste. At the end, zinc sheets are used to prepare the roof (ARCHITIZER, 2016).

2.2.2. STANDARDISATION MODULAR CONSTRUCTION

Modular design is an approach that subdivides a system into smaller parts called modules. Historically, in classical architecture, the diameter of a column was used as basis for a number of modules. The mathematician *Matila Ghyka's* invented the golden section[16], which granted a modular source for several architecture projects. In the French reconstruction, proportions and modules, became a central issue, as architects struggled amid changing procedures in building production. Modularity means using the same module in multiple configurations enabling a large variety of designs without using many component types. This brings several advantages such as reduced capital requirement, especially with large scale projects. Through modularity, you can achieve various designs – **adaptability** - while achieving **fast construction** for development, as well as, **cost saving** in design and construction (NADY, 2015).

2.2.2.1. ALBERGUES RUTA DEL PEREGRINO BY LUIS ALDRETE



F_049 House Ventilated Interior [ARCHITIZER, 2016]

Jalisco, Mexico [2010]

The strategy was to make a series of base modules, which multiply the project shape and thus have the capacity for adaptation and growth. The atmosphere makes sense when configured with two blocks of adobe colour that is one of the predominant shades of the region. One of them is fundamental to make a perimeter lattice in the buildings that translate the play of light and shadows generated by the covers of oak leaves used in most of the surroundings, which contain a large dose of sensitivity and spatial quality (ARCHITIZER, 2016).

2.2.2.2. NEW ARCHETYPES BY NUA ARQUITECTURE

F_050 Ventilated Front Wall. [DIVISARE]

F_051 Interior Divisions. [DIVISARE, 2015]

Spain [2015]

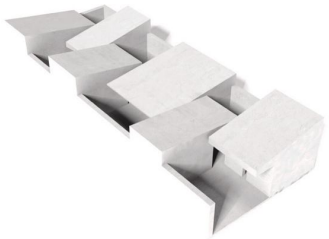
The NUA Arquitecture — *Ferran Guiamet*, *Arnau Ramos*, and *Maria Ruiz* — have dedicated their practice to working through ideas surrounding urban regeneration in Spain. They demonstrate an acute ability to transform the technical limitations of the project into an exercise that involves the community both during the construction phase and after.

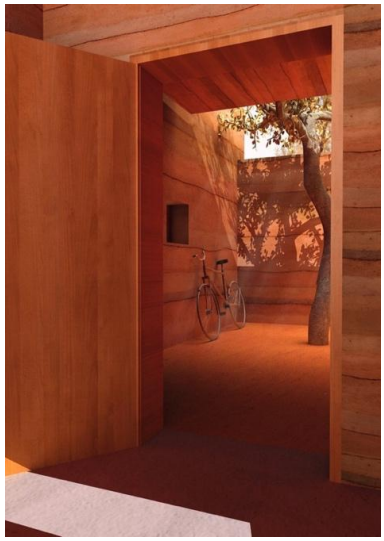
To tackle the time and monetary constraints, the architects conceived of a structure that was "easy to be built through using industrial construction systems." Utilizing corrugated steel panels to provide the roof and the exterior walls of the building, this material satisfies multiple project demands as it is a relatively cheap material that is easy to transport and install. The panels have been applied without any window openings on the façade so that the building is protected and secure (DIVISARE,2015).

[16] In the book "The Golden Number", Ghyka reveals how the Golden Number Phi underlies the spiritual nature of beauty and the hidden harmonies that connect the whole of creation.

2.2.2.3. HOUSE IN LUANDA BY LISBON ARCHITECTURE

Triennale [2010]
Pedro Sousa, Tiago Ferreira, Tiago Coelho, Bárbara Silva and *Madalena Madureira* developed the winning proposal. To build a home is to make room for light and shadow; of silence and noise; of relations and autonomy. Defining a transition between exterior and interior, collective and individual.
The house is defined by six patios that relate to the different functions of a home: kitchen and living-room, bedrooms and restroom. These six patios communicate through a central exterior corridor, protected from the rain. The result defines a house where the interior has a permanent relation with the exterior. An intimate and protected exterior, where each family member may have privacy and autonomy. The rammed earth which was used in the project is a low-cost, easy to build material, that guarantees good transversal ventilation systems and a good solar protection, and may also have a high thermal capacity (ARCHDAILY, 2010).





F_052-53 Model and Patio Views.
[ARCHDAILY, 2010]

2.2.3. SUSTAINABLE ARCHITECTURE AWARENESS

It is a negative strategy to set tradition and technology against each other. The most accurate approach is to overlap and apply both processes to tackle environmental problems. In the article '*Plus ça Change*', *Robert Venturi* declared that the Post-Modernism was just as exclusive as the movement it revolted against, treating history as pastiche, devoid of both context and content. Another point later substantiated by *Fredric Jameson*, is that the Post-Modernism was a continuation of a pre-existing value system, the approach was similar to the Modernism view of the vernacular as picturesque (STEELE, 2005 : 15). In the 19th century, the unhealthy endemic to industrialised cities gave rise to a "green for health" tendency.

Today, architecture has an ethic imperative to help solving world-wide severe problems like global warming, poverty, mass migrations and overpopulation. The urge for sustainability has changed the modern perspective in a new age exigency for and self-sufficiency. Designing according to nature, and to social-economic context, is seen as something for humans to value.

2.2.3.1. HOUSE FOR TREES BY VO TRONG NGUIA ARCHITECTS

Ho Chi Minh City, Vietnam [2014]

Under rapid urbanization, cities have much reduce the presence of green. In Ho Chi Minh City, as an example, only 0.25% area of the entire city is covered by greenery. Over-abundance of motorbikes causes daily traffic congestion as well as serious air pollution. As a result, new generations in urban areas are losing their connections with nature. The aim of project "*House for Trees*" is to return green space into the city, accommodating high-density dwelling with more greeneries. Five concrete boxes, each houses a different program, are designed as "pots" to plant trees on their tops. With thick soil layer, these "pots" also function as storm-water basins for detention and retention of water, therefore contribute to reduce the risk of flooding in the city when the idea is multiplied to a large number of houses in the future (VO TRONG NGUIA, 2014).

F_054 Patio upwards view. [VO TRONG NGHIA]
F_055 Patio view. [VO TRONG NGHIA]

2.2.3.2. CASA GABRIELLA BY TACO TALLER ARQUITECTURA CONTEXTUAL

Merida, Mexico [2012]

The architectural program considered a social area where the kitchen, living room and dining room meet; an intermediate zone of services where the bathroom and the laundry closet were located; and finally a bedroom. Both the social area and the bedroom feature rear semi-exterior terraces which are perceived as extensions. From the social terrace one can reach the back garden and an open patio on the rooftop. The climate of the region allows several apertures to be closed only by mosquito nets, permitting constant natural ventilation. The double heights have zenith openings that evacuate the hot air, achieving a comfortable internal temperature without resorting to artificial means (DIVISARE, 2012).

F_056 Front View. [DIVISARE, 2012]
F_057 Ventilated Wall. [DIVISARE, 2012]

2.2.3.3. LOW COST HOUSE BY VO TRONG NGUIA ARCHITECTS

Bien Hoa, Vietnam [2012]

The aim of this project is to propose a prototype house for low-income classes by minimizing the functions of the house and using local low cost materials. On the assumption that the bathroom and kitchen are placed outside and shared with several families, also the house has minimum space for living, eating and sleeping [ARCHDAILY]. The plan was designed to be adjustable longitudinally, allowing future expansion. Its interior is a simple one-room space, articulated by curtains and differences in level of the floor. To reduce the construction cost, dwellers are encouraged to participate in the construction process, since the structure of the prototype house is easy to assemble without the use of special techniques (ARCHDAILY, 2012).

F_058-59 Front View and Interior. [ARCHDAILY, 2012]

03. THE MUSSUS PROGRAM

3.1. THE MUSSUS IDEOLOGY

3.1.1. THEORETICAL CONCEPT

In the early 20th century, the concept of "*dwelling*" was defined as a "*machine for living*". Today, a century later, we face the challenge of constructing a sustainable or even self-sufficient dwelling. One that is connected to its environment, acknowledging the social, cultural, technical and economic conditions of its surroundings (IAAC, 2006 : 4). Compact cities strategy helps to mitigate the conversion of agriculture land into urban use. This can be achieved through redevelopment of existing low density built-up areas, promoting higher floor area ratio per plots and ensuring higher density. Slums that are upgraded and regularised often go through processes of densification by vertical growth (UN-HABITAT, 2012 : 50). A study that involved redesigning representative sectors of Buenos Aires concluded that *'it is possible to maintain the same densities but adopt different building forms to create better climate conditions outdoors and indoors without affecting initial or urbanisation costs'* (A GREEN VITRUVIUS, 2001 : 51).

There is little evidence of affordable land and housing in Sub-Saharan Africa. Housing programs are either not affordable or are insufficient (MAJALE, TIPLE & FRENCH, 2011 : 12). Although measures implemented by the construction sector in recent years have somewhat improved the situation, it still falls behind expectations. The sector can only reach its true potential by implementation of a new economic growth model based on ecologically sustainable development. In political terms, this will mean measures in such things as the promotion of usage of low-cost local materials, while simultaneously developing local typologies and construction techniques (GUEDES, 2014 : 422). Through dialogue, both, government and community collaboration can begin to lay out their responsibilities and design programmes that communities are able to respond to positively. It is an important part of the process that these establishment understand their responsibilities and how that is linked to the success of the programme (CITIES ALLIANCE : online source).

The occupancy of dwellings by successive generations of families, whose association with the building and the land is intimately related to their own sense of identity. People hold the capacity to construct dwellings and to shape their environments (OLIVER, 2003 : 16). This idea is very thoughtful, however people with fewer resources often build through common sense or improvisation. If communities came together in an all-around project that fixed all these difficulties, a change might occur. If a well thought and hands-on program drew the attention of the right people, it would be possible to gain the support of sponsorships from constructions companies and interested parties, be it common citizens or professionals, such as architects, engineers and constructors. In a non-profit project, is important also to guarantee the assistance of the Government, to facilitate the legalities, and perhaps a system of long term parcel payment (*cit in* CAIN, 2013 : 361-390).

The **MUSSUS** [**MUS**EKE + **SUS**TAINABLE = **MUSSUS**] programme embodies the social housing and urban renewal urgency required in the city of Luanda, Angola. The ideology stems to embrace the community needs and prospects, regarding environmental and economic issues in addition to contribute to a self-sufficient way of building. Adopting the combined concepts of social housing, modularity and sustainable architecture, that can lead to the transformation of slums in Luanda.

Therefore, in order to achieve those goals, the MUSSUS Programme principles are;

- **To create a module**, that can multiply, adapt and modify embedded in a standard construction, placed in a modular project, that climaxes individuality. To use passive methods and materials, to reduce the environmental impact. Contemplating the process of spatial evolution that accompanies the growth of families.
- **To create an intermediary instrument,** through self-manipulation, that can turn a concept into matter. In the shape of a form, with simple process explanations, that transports a sense of skill to conceive a singular project.
- **To create a movement** of mutual aid practices. A sustainable and self-sufficient mindset that would promote, recycling and maintenance into rehabilitation. Integrate professionals, such as architects, engineers, psychologists, professors and any expert that can improve the process and experience.

3.1.2. INSTRUMENTS OF URBAN INCLUSION

The Five Principles of Sustainable Urban Neighbourhoods recommended by the UN-Habitat settlements programme in the published strategy paper '*Streets as tools for Urban Transformation in Slums'* (2014 : 5) are:

1. **Adequate space for streets and an efficient street network***;* The street network should occupy at least 30 per cent of the land and at least 18 km of street length per km².
2. **High density**; There should be at least 15,000 people per km², that is 150 people/ha.
3. **Mixed land-use**; At least 40 per cent of floor space should be allocated for economic use in any neighbourhood.
4. **Social mix**; The availability of houses in different price ranges and varying tenures in any given neighbourhood to accommodate different income level.
5. **Limited land-use specialisation**; This is to limit single function blocks or neighbourhoods; single function blocks should cover less than 10 per cent of any neighbourhood (UN-HABITAT, 2014 : 5).

According to UN-HABITAT, Slum Upgrading consists of physical, social, economic, organisational and environmental improvements undertaken cooperatively and locally among citizens. Policy actions typically include: installing or improving basic infrastructure, water reticulation, sanitation/waste collection, flood prevention and security lighting. These upgrades incentives community management, maintenance, regularising security of tenure, home improvement, constructing or rehabilitating community open space, supporting local economic development, etc (UN-HABITAT, 2012 : 20).

By the mid-1980's, participatory slum upgrading was largely accepted, in policy and practice, throughout the developing world. UN-HABITAT discourages single settlement upgrading with questionable impacts and little contribution to the citywide development process, stating that *"A slum upgrading program is not a collection of actions to be performed independently of each other. It's an integrated intervention aimed at improving the characteristics of a neighbourhood and its inhabitants' quality of life"* (UN-HABITAT, 2012 : 21).

Citywide slum upgrading programme can trigger urban transformation and impact the spatial structure of cities. However institutional and land tenure complexities, tend to complicate the process (UN-HABITAT, 2012 : 24). The participatory planning approach, through community involvement, is important because of sensitive decisions, such as demolitions, reconstructions and relocation. Street upgrading provides an opportunity for the community to become involved in the layout definition, materials and construction itself (UN-HABITAT, 2012 : 29). *"The Street-Led approach connects and reconnects slums with the rest of the city by opening up space for infrastructure provision and income generation, enhanced security of land tenure and setting the basis for slums to transform themselves into future vibrant neighbourhoods."* (*cit in* KLOAS, 2012 : 13). A Street-Led approach to slum upgrading presents a practical case by gradually integrating slum settlements with the urban fabric (UN-HABITAT, 2012 : 13).

Streets in slums have multiple functions, since they represent the only public space available. Streets are host to multiple activities, such as informal commerce. Boundaries between public and private space often get blurred, since houses use streets as outdoor extensions of living space (UN-HABITAT, 2012 : 24). The street-led strategy for citywide slum upgrading recognises that well designed streets provide the ideal conditions to fit in public lighting and drainage systems which improve safety in slums (UN-HABITAT, 2012 : 45). Nevertheless streets only provide the basis for an integration into the urban fabric, while the inclusion of public utility services poses another challenge. The World Bank has been promoting this methodology in fifty-two cities in fifteen countries, mostly in Africa, with a great deal of success (UN-HABITAT, 2012 : 31).

The street-led approach advocates a phased development, focusing on a few streets to trigger subsequent development. Revealing three simultaneous processes over time (UN-HABITAT, 2012 : 37):

1. The slum dweller becomes a citizen;
2. The shack becomes a house;
3. The slum settlement becomes a neighbourhood.

3.1.3. THE MUSSUS COMMERCIAL AND MUTUAL SPACES

From the Street-Led to Street-Addressing approaches, is possible to reform the way the irregular streets are lived, changing the social dynamics of the actual unruly structure.

The city of Luanda is characterised for it's informal commerce, mostly by women, that make the streets their avenue of income. However, this practice is severely persecuted by the local authority. It is imperative to re-define the meaning of earning a living in the streets, which leads to giving these people a safe environment. To create the premises for that, there will be streets dedicated particularly for commerce activity [designed with the housing plan] and more private streets dedicated to the community identity (reinforcing recreation places, street art divulgation and public discussion).

According to the online report *"Privacy and Community in Co-Housing",* written by *Nathan Majeski* and *Linda Hallgren*, there are four designated community layouts which are the regular and irrelular musekes. The regular *musekes* represent the linear and the irregular *musekes* represent the dispersed, roughly despite the higher density and divergence from *musekes*.

Common denominators of contemporary slum upgrading interventions in cities like *Medellin, Rio de Janeiro, Mumbai, Ahmedabad* have involved the opening of streets and the (re)planning of settlements to physically connect them to the formal city and its urban management systems (UN-HABITAT, 2012 : 21).

"*By laying streets and opening up public space in slums, we are not only delineating public and private domains. We are establishing the basis for people to live a life in dignity, providing them with an address, accessibility to public services and creating the opportunities for urban regeneration that ultimately encourages prosperous and inclusive cities."* (*cit in* KLOAS, UN-HABITAT, 2014 : Foreword).

The first step into rehabilitation of existing *musekes* is to promote the redesigning of the streets, by defining an original layout based on community contact within the territory. Abrasive interventions that can alter the way of living needs to be avoided, however it is vital to grant chirurgical demolitions to create public green spaces previously non-existent in the *musekes* of Luanda. Subsequently, to reassure the effectiveness of the inclusion between the Centre [planned city] and the Periphery [*musekes*], the aim of the **MUSSUS** programme is to recommend the outline of two main and orthogonal streets, following the principles of Ancient Rome, of a *Cardo* [North- South] and a *Decumanus* [East West]. These two roman streets served as regulators to expand the city, and the suggestion of a *Commercial* and a *Mutual* street, from **MUSSUS** programme, is to establish lines of inclusion.

3.1.4. VOLUNTEERING AND MAINTENANCE

In Angola, social networks of solidarity coincide with neighbourhood spaces when linked to kinship. In such a situation people belonging to the same family live near each other and help assist one another (OPPENHEIMER & RAPOSO, 2007 : 170). Since *musekes* keep increasing, so are a lot of the issues that they represent. Furthermore corporativism and associationism should be encouraged, leading to a network of solidarity and cooperation among citizens (GUEDES, 2014 : 423).

"Self-sufficiency is an indispensable measure." (*cit in* KLOAS, UN-Habitat, 2014 : Foreword)

A project that targets a self-constructed system of building houses is not a new concept. In Europe, for example, there are a few working programs that value the idea of volunteering amongst a community. *Proficient* is a response to the EU wide trend of self-organised housing process to boost the quality and scale of energy-efficient buildings. Self-organised housing process, in which a group of homeowners carries out new construction projects, on a district scale, reflecting sustainability awareness (PROFICIENT EU: online source). A similar concept of 'owner-builder' occurs in Angola, as the owner acts as both 'architect' and 'contractor', determining the space layout, building materials, mobilising family labour and financial support. Although this self-aid process is time consuming, it is well-suited to the financial capacity of the household (*cit in* CAIN: 361-390).

In *Angola* the monopoly of political authoritarianism discouraged social initiatives by the people and for the community. In the '90s, for example, on Sundays, leadership actions called for a neighbourhood cleanse, and this sense of organisation was since lost (OPPENHEIMER & RAPOSO, 2007 : 172). Promoting public participation in urban planning, empowers communities and results in more responsive outcomes to the people's diverse need (UN-HABITAT, 2015, *Planning Sustainable Cities :* 19). Once physical improvements have been done they must be maintained. That usually involves joint funding and cooperative efforts of the private sector and city Governments.

Continuing community involvement makes possible for a place that has been rejuvenated, not to fall back into disrepair. This commitment usually evolves from people's first-hand participation in the planning process. When people have a direct decision power, they develop a strong sense of ownership that leads to their active involvement in improvement and maintenance activities. This kind of community stewardship gives citizens the confidence that they can control their environment (ARRP, 2009 : 30). UN-HABITAT works at neighbourhood level, with participatory urban appraisals and community action planning in a variety of contexts, such as slum upgrading, community development, and post-disaster reconstruction. This has proven effective in stimulating and structuring public participation in local government and in urban planning processes (UN-HABITAT, 2015 *Planning Sustainable Cities :* 19). In the *Asian* countries of *Afghanistan, Indonesia, Pakistan* and *Sri Lanka,* in a post-conflict context, a major reconstruction project took place. And its results demonstrate the potential of the people directing their creativity into rebuilding their lives (UN-HABITAT, 2015 *Planning Sustainable Cities :* 21).

3.1.5. RECYCLING

The more production equals more waste and more waste creates environmental concerns of toxic threat. An economical viable solution to this problem is the utilisation of waste materials in order to create new products. Recycling of waste construction materials saves natural resources, saves energy, reduces solid waste, reduces air, water pollutants and greenhouse gases (BOLDEN & ABU-LEBDEH and FINI, 2013 : 14). Construction waste recycling is the separation and recycling of recoverable waste materials generated during construction. The refurbishment of materials can advocate for the environmental crisis, create job opportunities and transform a priceless piece of object into an integrated construction element.

According to the report *More Jobs, Less Waste* (2010 : 18) by the *Friends of the Earth*, in the US, recycling programmes have been reported to provide higher average wages, than conventional waste disposal sectors and also provide a good return on capital investment. These authors also found that for every 100 jobs created in the processing and manufacturing of recyclable materials, only 13 jobs were lost in corresponding up-stream and down-stream industries. The Northern Ireland Business Organisation, stablished recycling options for a list o materials:

RECYCLING OPTIONS FOR GLASS
1. Aggregates
2. Decorative materials
3. Manufacturing of bricks and ceramics
4. Insulation
5. Containers

T_08 Glass Recycling Options. [NIB]

RECYCLING OPTIONS FOR PLASTIC
1. Drainage pipes
2. Ducting and flooring
3. Packaging
4. Landscaping
5. Textile fibre
6. Street furniture

T_09 Plastic Recycling Options. [NIB]

RECYCLING OPTIONS FOR WOOD
1. Surfaces and pathways
2. Fibre composites
3. Architectural components
4. Landscaping

T_10 Wood Recycling Options. [NIB]

Most glass waste is produced by demolition projects and the replacement of windows in refurbishment projects. It also comes from; fluorescent lighting, PC monitors and TV screens.

In the construction industry, plastic is mainly used in; pipework, insulation, wall coverings or flooring and window frames.

The main causes of wood waste are; pallets, beams, window and door-frames, doors, floorboards and fencing.

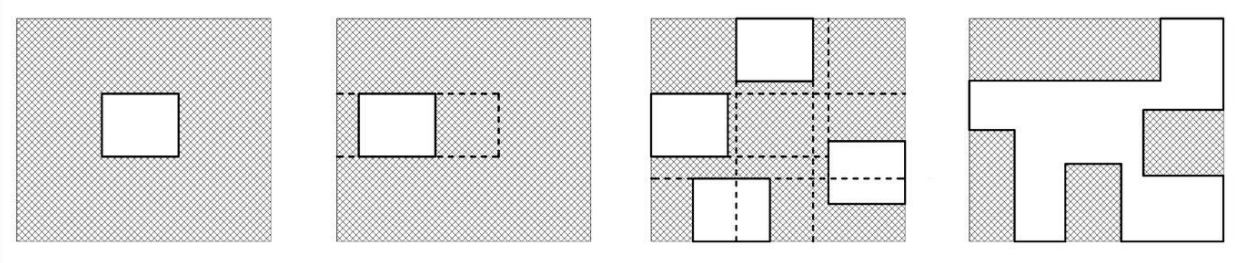
3.2. THE MUSSUS CONCEPTION

3.2.1. THE MUSSUS HOUSE

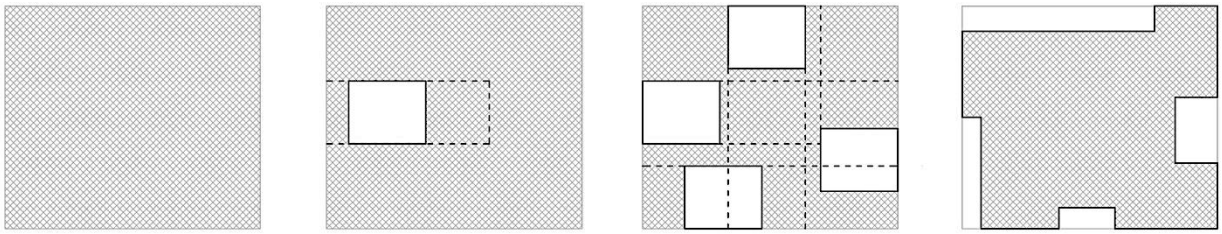
The broad project is to develop a Social Housing Programme, in the context of UN-HABITAT and Proficient-EU concepts of slum-upgrading, passive design and community volunteering work. Introducing the concept of ZEB house [zero net energy], increasing the renewable energy of the construction, through passive design techniques. Assisting the conception of mass-construction houses, by standardisation and schematic module, providing house diversity and enlargement adapting to each family needs. Therefore maximise the energy consumption by economising, the budget costs, through the use of local materials. The line of reasoning is to create a module that must commit to a sustainable configuration and should acquire the characteristics of pragmatic constructions accordingly.

In the chapter [2.4] the courtyard model is considered the best option for the climatic context of Luanda. As a principle of bringing diversity, the patio is multiplied, awarding a succession of different solutions for the constructed and open areas. Similar to the *House of Trees* [2.2.1] case of study.

F_060 Regular; Patios, empty and full, Movements Illustration. [Author]

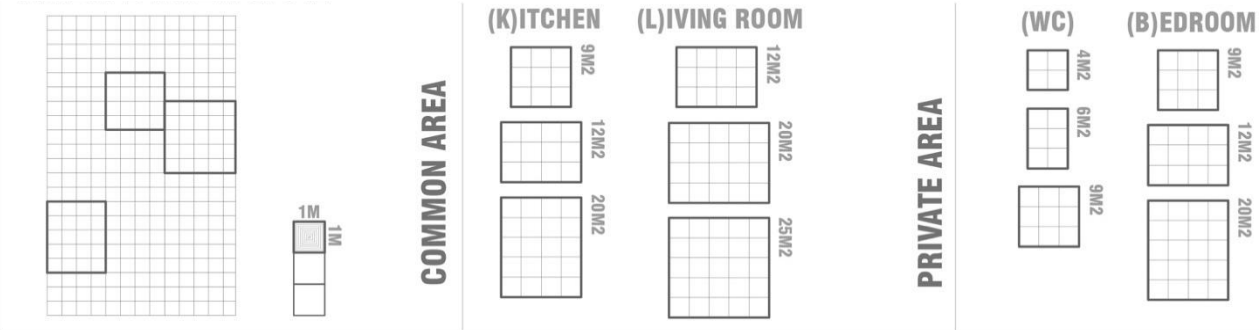


The module concept in the regular case consists in arranging blocks around the terrain, thus creating various patios, while in the irregular case the practice is cutting patio incisions into a massive block, like a negative imprint.



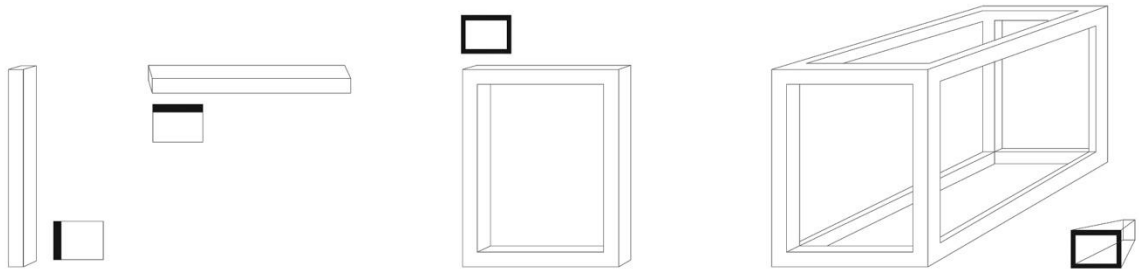
F_061 Irregular; Patios, empty and full, Movements Illustration. [Author]

In the Regular Case, each building block represent a different function, conventional or not, they are decided by the families themselves. However, in order to facilitate this process, is important to define designed spaces with according dimensions. Stipulating the maximum total area of the house, whereas between 150 to 200 square meters, managing the overall budget that is required to stay low-cost.



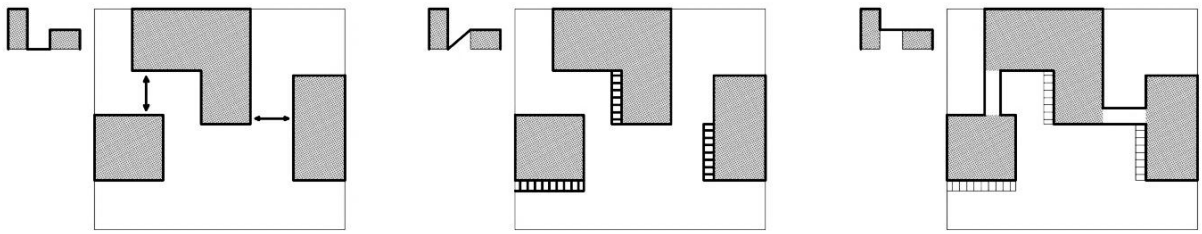
F_062 Functions and Areas Illustration. [Author]

The efficiency of the standard module is only possible if the constructive system follows the same train of thought. The structure base of the houses would be defined by the outline of a cube, pillars and beams. The filling of structures would then be cement blocks masonry made in real time or even pre-fabricated. The exterior walls should be strategically perforated as to facilitate the passive performance, as represented in the *Casa Gabriella [2.3.2]*, *Albergues Ruta del Peregrino [2.2.1]* and *New Archetypes[2.2.2]* cases of study.

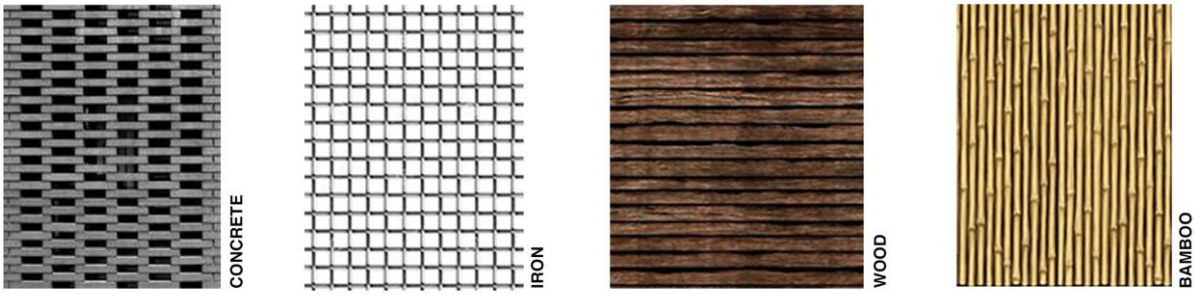


F_063 Structure Standard Module. [Author]

The remaining patio spaces would integrate, pathways for crossing and planting spots. Is relevant to sustain the concept of green areas, as in the *House of Trees* case of study, even in terraces, arranging spaces dedicated to agricultural needs – for a self-sufficient life – and air renewal. To adopt an evolutionary spatial module, is necessary the definition of flat roof-tops, that can be adapted into functional spaces. The terraces are the basis for future expansions of the house. The blocks should be put apart, occasionally together, in order to maximise ventilation between and through them. To minimise the construction area, since the blocks are separated, the links – stairs and bridges – are outlining the blocks.



F_064 Stairs and Bridges Illustration. [Author]



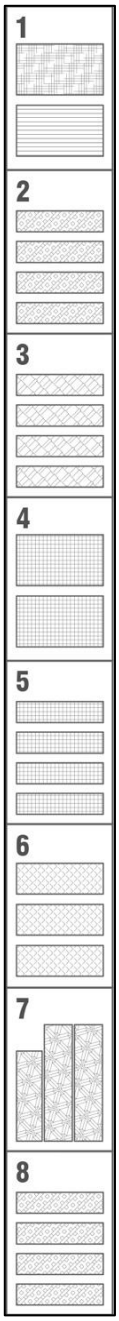
F_065 Concrete, Iron, Ripped Wood and Bamboo for Complementary Walls. [Author]

The *Tokolor*, tribe from Senegal, dwellings are notorious for their mosaic of perforations and screens facades. This vernacular solution is remarkable for protecting the interior from solar exposition, thus allowing illumination, and a ventilation regulator [BOURDIER & MINH-HÁ, 2011 : 127]. To integrate the structural walls, the plan would follow a range of simpler wall elements. These elements should be made of lightweight materials, to facilitate transportation, and be mutable to diverse needs. As represented in the *New Archetypes [2.2.2]*, *Chacras Pop Up [2.1.2]*, *Ruca Dwellings [2.1.3]* and *Low Cost House [2.3.3]* cases of study, these elements - viable due to the region climate of Luanda – can be easily manufactured and customized with mosquito nets, permitting constant natural ventilation.

3.2.2. INDIVIDUAL FORMS

The standardisation of social housing processes is noted to be an efficient, economical and practical solution. This has been applied worldwide, however the lack of sensibility in projection can cause the exclusion of these settlements. To define a module that repeatedly multiplies the same characteristics, is to create a neighbourhood with no identity. Is important to model each house according to its occupants, and its requirements will certainly differ. The trouble in distinguishing a house from the next one, will diminish the sense of property. The African *Soninke* tribe, have been traditionally building singular houses, despite the common use of identical materials, plan and general spatial organisation in their village. Each "owner" participates in the dwelling's design, realisation, and altering as the life rhythm demands. It serves as a social regulator, reinforcing a spirit of mutual aid and encouraging creativity (BOURDIER & MINH-HA, 2011 : 25). This organization system is a part of the African culture, and the African society drifted away from that, influenced by western concepts.

The creation of **MUSSUS** house, will rely into an auxiliary component – an individual form – which consists in a grouping of setup pages that will permit different families to draw their own houses based on a modular segment, structured to allow diversity and singularity into a housing programme. These modular individual forms will reinforce the emotional link of family to house, and consent different creations over the same concept, essentially defining a singularity of houses and still being read as a plurality, revolutionising the way social housing conjuncts are normally done. The whole process will be closely followed by professional supervisors. This represents a great opportunity to include community work and is a convenience to possibly instruct non-qualified people and tutor voluntary work by students.



Page 1 presents the neighbourhood masterplan, as well as the borders of the block and house location. In this section the family size is referred, introducing information, such as number of household inhabitants, kinship and ages. Followed by observations, the personal information will facilitate the supervision process.

Page 2 presents an explanatory illustration regarding passive design and the best solutions to optimise the weather features into creating comfortable interior conditions.

Page 3 presents also an explanatory illustration, concerning the concept for building the house, as defined in the previous chapter.

Page 4 presents the plans of the house - assisted by guide and support lines, perpendicular, orthogonal and obliquus.

Page 5 presents technical drawings, precisely the house sections and elevations, this section, adversely from the rest of the form, is performed only by specialised individuals.

Page 6 presents the possible solutions for structure and auxiliary walls. This section aids the process of creating the brick and perforations performance enhancing the singularity factor. Also defines the typology and materials for the auxiliary walls.

Page 7 presents the possible solutions for materials, low-cost and high-cost, the decisions include, pavement, brick wall, door, window, roof, canopy, envelope coating, stairs, bridges and banister guards. Associated with the material and constructive techniques,

Page 8 presents the budget of the overall construction work to be done, allowing low-cost restrictions to succeed.

F_066 MUSSUS House Form Illustration. [Author]

3.2.3. TEXTURE AND MATERIAL

The effectiveness of a building envelope is directly related to the choices made regarding materials and construction, that is, the thermal properties that each material has, and the properties they have when combined together to form building elements. The manner in which a material will react to thermal forces will be determined by its thermal properties; **(1)** Reflects heat, **(2)** Absorbs heat, **(3)** Emits heat, **(4)** Reduces the flow of the heat, **(5)** Stores heat and releases it (KOCH-NIELSEN, 2002 : 96). In the climatic zones, the choice of the materials, trough a guide, for the building envelope is crucial to avoid unwanted heat radiation in interior environments.

THERMAL EFFECTS ON MATERIALS	
RADIATION	The impact on the exposed surfaces of materials either as direct solar radiation from the sun or as a radiant heat exchange with its environment.
CONVECTION	Is the heat transfer by air movement to a material.
CONDUCTION	Is the process of heat transfer trough a solid material from the hot side to the cool side.

T_11 Thermal Effects on Materials. [KOCH-NIELSEN]

MATERIALS	REFLECTIVITY (%)
Brick and concrete, light	40
Concrete, smooth	20
Tiles, white glazed	80
Asphalt	10
Sandy soil	25
Dark, cultivated moist soil	10
Grass	25
Vegetation, light	25

T_12 Reflectivity on Materials. [KOCH-NIELSEN, 2002]

Some materials have properties that will reflect heat rather than absorb it. The reflectivity properties of a surface are generally associated with colour - lighter-coloured surfaces reflect radiation more than darker-coloured (KOCH-NIELSEN, 2002 : 98). On the other hand, Absorptivity and Emissivity Properties is the absorption of transferred radiation to an opaque surface if not reflected. Absorption involves heat gains whereas emittance involves heat losses (KOCH-NIELSEN, 2002 : 102). Air is one of the best insulators, as materials and buildings elements that enclose air, have low heat transfer characteristics. The resistance to heat transfer of a wall or roof can be increased by the creation of air cavities between the layers of construction (KOCH-NIELSEN, 2002 : 103-112).

According to the *Sustainable Building Design*, a material's life cycle has three phases. The Pre-Building phase describes the material's manufacture, such as extraction, processing and shipping. The Building phase that consists in the materials usage, such as construction and maintenance. The Post-Building phase that defines the material disposal, avoiding waste, trough recycling [KIM & RIGDON, 1998 : 7-8]. The reduction of construction waste as previously described in the chapter [4.1.5], recycling is one of the solutions to a sustainable approach. Nevertheless the use of locally produced building materials shortens transport distances, thus reducing air pollution produced by vehicles (KIM & RIGDON, 1998 : 15).

F_067 Argillaceous Earth. [MADEHOW]

For centuries, earth moulded the huts and compounds of sub-Saharan West Africa, the construction methods were taught personally by generation to generation. The walls were made following five basic types of soil [gravel, sand, silt, clay, and organic], and the dirt in a given location is generally a combination of all or most of these types (OLIVER, 2003 : 97)(MADEHOW: online source).

F_068 Straw Pile. [RODALES ORGANIC LIFE]

The straw has been used as a construction material in Africa since the Palaeolithic Era, precisely the rooftops. Is a relatively sustainable construction method because of its availability and renewability [100% biodegradable]. Straw bales take little energy to manufacture and due to its organic composition containing air allows walls to perspire (BUILD ABROAD : online sourc).

F_069 Palm Tree. [PIXABAY]

The coconut palm tree is the best resource for wood, since translates not only resistance and durability – necessary for construction – but because unlike many other types of trees, it can grow rapidly within only a few years, being eligible for frequent consumptions (SUSTAINABLE MATERIALS : online source). The wood in old construction sites can also be recycled as described in chapter [4.1.4].

F_070 Steel. [FERRO GALLIANNI]

Steel represents strength and manoeuvrability in construction. Even though its production demands a high consumption of energy, the recycling of metals emits less carbon dioxide. Also, metals can be recycled repeatedly without altering their properties., more importantly, it saves money and allows manufacturing businesses to reduce their production cost (THE BALANCE SMB : online source). Its strength to weight ratio makes it the perfect option to reinforce or joint other building elements. As well as a base element to support others – straw, wood, concrete – in order to form complementary objects.

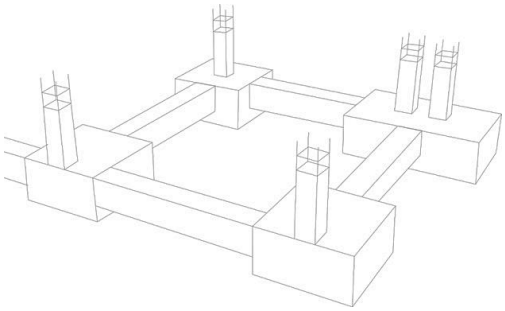
F_071 Cement Powder. [THERMO FISHER]

Cement is important in construction as a binding agent. Mortar is cement mixed with sand, used for binding bricks and blocks in walls or surface renderings. Concrete is a mixture of cement, sand or other fine aggregate (BRITANNICA : online source). The concrete aggregate collected from demotion sites can be crushed to minuscules particles and then filtered and re-used for new construction purposes. This process reduces construction costs and the pollution generated when compared to the production of new products [chapter 4.1.5]. Cement based products are normally prefabricated, which makes them the perfect ally for a modular project.

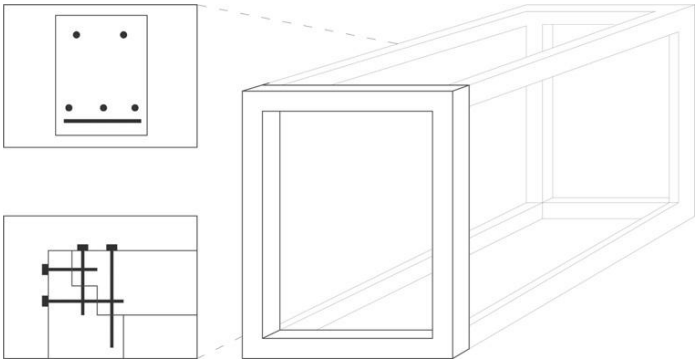
4.2.4. CONSTRUCTION ELEMENTS AND ESTIMATE

Foundation and Structure Module Reinforced Concrete

The foundation for the regular case is superficial, as it supports only two stores maximum, whereas the irregular case is semi-deep, since supports up to four stores maximum. The foundation schematic is set to follow the area boundaries and consequently the structural module would be set upwards trough steel joints. According to CYPE construction estimate simulation based in the Angolan market. The superficial foundation is 27.934,82 (aoa) per square metre – ~102,39 (eur) / m^2 – and the semi-deep foundation is 12.687,20 (aoa) per square metre - ~ 46,50 (eur) / m^2.



F_072 Superficial Foundation. [Author]



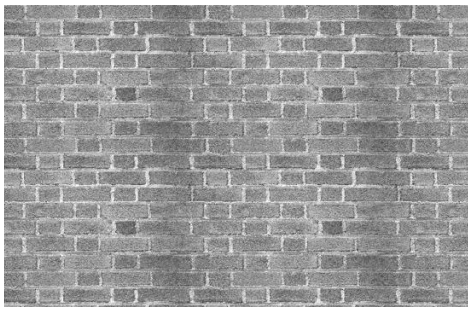
F_073 Structural Module Sections. [Author]

The structural module a combination of pre-fabricated reinforced concrete pillars and beams. The beams are especially reinforced in the south area, in order to resist gravity natural tension forces long-term. The two separated elements are joint with steel screws. The module can be easily put together - with different composition sizes - in site or transported in unity. The module estimate is oscillating around 251 232,16 (aoa) per unity - ~920,86 (eur) / un.

Auxiliary Perforated Walls Mud and Cement Bricks, Bamboo, Straw, Steel and Ripped Wood

Mud-brick walls foundations require concrete work two metres below grade and one metre above. The addition of chopped straw reinforces and controls shrinkage cracks in the drying process. Is important to control the water-to-mud ratio - since too much water weakens the mixture - the mud mix should be stiffer so bricks are ticker and stronger. The mould and building process of the bricks is similar to the cement brick walls (JEROME, Pamela, 2010 : 55). The foundation is set ten centimetres wider than the width of the block. The line of concrete blocks should rest on top of a of mortar mix layer – this process is repeated. The blocks at one point will need to be cut so they can be installed in corners and along joints (THEBALANCE : online source).

F_074 Adobe brick wall masonry. [DREAMSTIME]



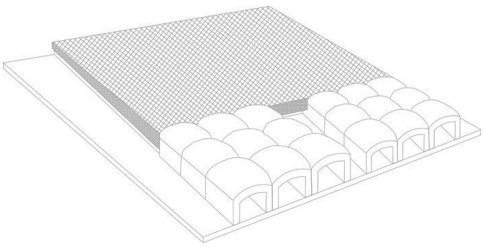
F_075 Cement brick wall masonry. [TEXTURES]

According to CYPE construction estimate simulation based in the Angolan market. The cement brick masonry is 2.933,70 (aoa) per square metre – ~10,75 (eur) / m². Although it was not available to verify the estimate for adobe brick walls, the cost would be substantially less.

F_076 Bamboo panel. [WAYFAIR]

Bamboo is extremely durable material due to its composition. It has no rays or knots, unlike wood, so it can withstand more stress. External uses for bamboo stands for structural frames to corner posts, joists, tie beams, rafters, roofing and even exterior walls. Bamboo, straw, steel and ripped wood are materials that can be used to introduce screen panels as complementary elements to structure walls. Some of these elements can be easily manufactured by common people, and other pre-fabricated in factories, and steel frames would conjoin all separated elements.

Elevated Platform Pavement



F_077 Cavity Ventilated Ground Floor [Author]

The first step is excavating the area for the floating deck. Then to set the corners creating holes for concrete blocks, spaced accordingly to volume ratio. After setting, make sure they're levelled, then pour wet concrete mix. Let dry and lay the pressure-treated platform joists – to receive other structural elements later (DIYNETWORK, 2012).

This type of platform is estimated to be approximately 5 732,94 (aoa) per m² – 21,16 (eur) / m². This budget is utterly based in a simulation – CYPE – based in the Angolan market prices, and so it excludes any other essential tools and labour to make the construction possible, such as; demolition, transportation, sanitation network, skilled labour, etc..

Rooftop Terraces

F_078 Pre-Fabricated Slab. [CYPE]

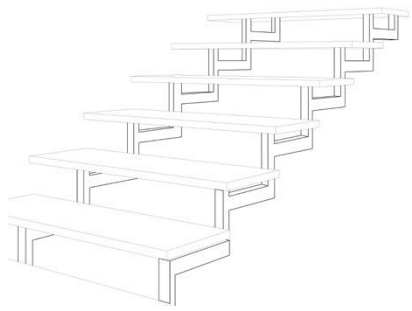
Structural precast concrete panels are a durable and versatile building material. These elements meet the structural needs of every type of domestic construction and are mostly locally manufactured and transported short distances to sites, this reduces the transport component. Terraces, balconies and roofs should be waterproofed by placing a solid or liquid asphalt screen, following a protective screed and finished with a layer of waterproof coating. Pre-fabricated steel beams and pillars can be used to reinforce the vertical and horizontal structures of the house (YOURHOME, 2016)

According to CYPE construction estimate, a pre-fabricated slab with reinforced steel would retail at around 5 724,02 (aoa) per square metre – ~20,97 (eur) / m².

Stairs and **Bridges**

The construction of the circulation systems of stairs and bridges would be supported by steel elements of sustentation and joint purposes. The bridges in particular must erect from a metal truss structure, and its length should be restrained – up to 3 metres – in order to avoid more complex and expensive outcomes. And later complemented by another material, preferentially wood or concrete - since the circulation is made outdoors - metallic materials should be chosen and placed strategically because of high levels of radiation absorption.

The construction estimate for the stairs steel structure is about 1 469,79 (aoa) per square metre – 5,38 (eur) / m² – and the bridges steel structure around 1 231,74 (aoa) - ~ 4,51 (eur) / m². This estimate only calculates the cost of the material elements, excluding other essential costs in the process of building the structures.



F_079 Steel Structure for stairs. [Author]

F_080 Steel Structure for bridges. [CYPE]

04. FIELDWORK

4.1. OBJECTIVES AND METHODOLOGY

The research done previously, in the chapter [01], tackled the social and economic aspects of the Angolan society, as well as an analysis on the urban expansion of the territory, which made possible to create a portrait of *Luanda*. However, since most of the available data and information are outdated for up to 10 years, it is important to verify the material gathered, in order to guarantee the current legitimacy of any future intervention. Therefore a journey to the city of Luanda was prepared, with the objective of surveying the critical areas described - so as to verify its actual state – through photographic records and questionnaires. Resuming these experiences with specific reports; the first to the Rehabilitation Centre of *Sambizanga* (to make aware of the interventions been implemented in *musekes* currently by the Government), the second and third subjects are visit reports of a regular – Bairro Operário - and a irregular – Rangel - *musekes*.

4.2. GTRU SAMBIZANGA AND CAZENGA

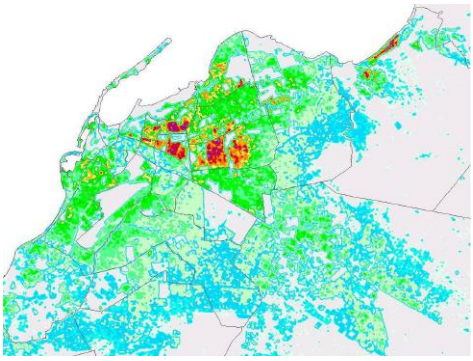
4.2.1. VISIT REPORT

17th and 18th January, 2018

F_081 Sambizanga *Museke.* [Author]

The Technical Office for the Urban Reconversion of Sambizanga and Cazenga *musekes* is one of the qualified and active entities in the process of implementing the Luanda Master Plan [PDL] decided in 2014. This plan revealed the motivations and future long-term investments of the Provincial Government of Luanda, and mainly seeks to solve the problems of shortage of adequate infrastructures, basic sanitation, road and pedestrian circulation, public space and housing. The road traffic systems are predicted to undergo a process of definition of main, secondary and tertiary routes. The radial design of Luanda's city nucleus requires a radiocentric scheme for new roads, as they represent the most viable and profitable solution. Public space and housing are also a target of the new PDL - excluding the city centre and certain recent housing interventions built on the periphery.

The housing construction experienced in informal neighbourhoods represent the high population density of Luanda. Where the demand is greater than the supply, and the lack of resources - at both Governmental and individual levels - has aggravated this reality after the rural exodus.



G_05 Luanda's Populational Density. [DW, 2005]

Irregular *musekes* located on the outskirts of the city centre, as well as informal constructions alongside main roadways, are the Master Plan's priority areas. However, in order to proceed with the construction of the necessary infrastructure, it is crucial to demolish a significant amount of informal settlements. Meanwhile, the *musekes* of *Sambizanga* and *Cazenga* revealed more execution urgency since it represents the denser area - in terms of population and construction - of Luanda [marked in red], reaching in some cases, 100 000 inhab / km^2.

The work construction visited is framed in the first phase of the rehabilitation project in *Sambizanga*, which was briefly explained with the accompaniment and support of the architect *Ilídio Daio* and architect *Miguel Dias*, and engineer *Armindo Machado*.

The first step is to define an area - close to the intervention zone - with moderate dimensions. The empty spaces in the defined urban area are identified, which would then allow the design of the housing plan – that according to the total dimension - would include public spaces, schools and administration at the neighbourhood unit level. The social housing model is vertical – since the high density of *musekes* demands the creation of additional dwellings - consequently housing more families in less space. The use of elevators and expensive equipment should be avoided, so buildings are up to 4 floors – also because of the cost of semi-deep foundations – since buildings higher than 4 floors would highly increase the budget limits. The areas to demolish are defined in phases - giving priority to areas of risk and urgency of relocation, and areas that occupy the zones of planned construction of new infrastructures, following the PDL recommendations.

F_082 Housing Unity Plan of Sambizanga. [Author]

Before demolition, the areas in order of priority phases, go through the process of registration of families by dwellings. According to Drª. *Elisabete Oliveira*, firstly a group of technicians divulge, in the streets, the process of registering houses and families. After three days of creating awareness, twelve technicians start the registration, dividing into groups of two, with the purpose of analysing up to 10 houses a day, the equivalent to approximately one block. The family registration process reveals the number of people living in the same household and their kinship, as well as their age and gender. While the registration of the houses classifies the type of construction (i.e. houses of stone, brick, concrete, steel panel, etc.), it calculates the complete area and defines the number of spaces (i.e. rooms, rooms, kitchens, etc.). The house's extensions, constructions adjacent to the main dwelling, of close relatives, have a high incidence in Luanda's *musekes*. Although land values near the centre are too expensive - which do not fit the common Angolan - there is power of tradition, as citizens keep the future generations in their "backyard", living next to each other. Highlighting the number of annexes, it is often only possible to house the main owners of the initial land, however, each annex increases the value of the house and consequently the value of the compensation.

F_083-85 Surrounding of the Housing Neighbourhood. [Author]

After the construction work of the housing plan is concluded, the critical areas are demolished as soon as the inhabitants are rehoused. This process is repeated gradually, area by area, fulfilling the Master Plan and rehabilitating a large area of the *Cazenga* and *Sambizanga museke*.

In the case of constructions previously demolished, at the time of my visit, the respective families were already properly relocated to *Zango V*. The whole process of transportation of people and goods is the responsibility of the Provincial Government of Luanda. It is not always possible to transfer the families to the same neighbourhood, so they are often relocated in periphery centralities – township settlements. The real challenge for these families will be to live in a neighbourhood built for the purpose of relocation, away from their previous home and their daily lives.

F_086 Secondary School for the Housing Neighbourhood. [Author]

4.2.2. THE PROTOTYPE OF SOCIAL HOUSING IN LUANDA

[Authorship of architect *Miguel Dias* with the collaboration of architect *Acácio Manuel* in Prototypes of Social Housing in Urban Regeneration Operations]

The demand of building the maximum number of dwellings at the lowest possible cost implies restraints in the decision of the minimum building areas. The PDGML in Luanda points out the need of constructing about 830 000 house units by 2030.

Accordingly, is defined the criterion of 2 people per room, considering that a two-bedroom apartment can accommodate up to four people. Therefore, a financial feasibility comparison study is made - between the GDP per capita ration and the functional minimum areas used in social housing - in three countries that have a similar population density.

The GDP per capita of Angola is equivalent to 3 110.81 (usd), following the brief analysis of costs and the reality of the families in the *musekes* is chosen the limit of 12m^2 of floor area per person.

After the construction and relocation processes are done, is necessary to unravel the economic accessibility. Considering the construction cost of 400.00 (usd) per metre, we will have the following costs per type:

T2 21.600,00 (usd) **T3** 28.800,00 (usd) **T4** 40.000,00 (usd)

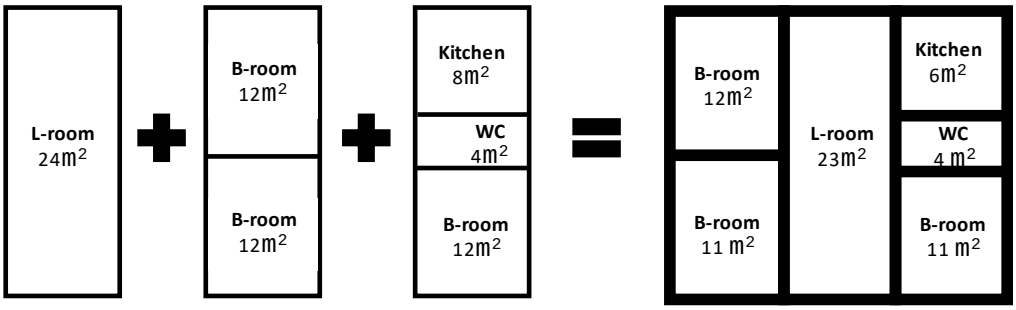
The Government assumes the costs of infrastructure, and construction costs are to be paid through the resilient income system, which would be charged under the following conditions; annual interest of 5%, 20-year repayment-term and 25% effort rate. However, in rehousing operations it is the State's responsibility to compensate the citizen for the demolition of his dwelling, for which reason the value of this compensation reduces the payment of the new property. Speculating that this reimbursement would represent half of the value of the new house, it would be accessible to 72% - 85% of the families.

Still about 15% of the urban population would not be able to pay the rent. Other mechanisms of refund remain to be found for this layer of the population. [These calculations were made using the tool provided online by the *Centre for Affordable Housing Finance in Africa*, based on the income structure of Angolan urban families.]

F_087 View from external gallery. [MANUEL, Acácio]

In the conception of the apartments the accessibility adopted is by **external galleries**, which functions as **an extension of the residence**, providing space for activities to be carried out abroad, as well as space for **interaction among neighbours**. These galleries also establish a **connection with the surrounding public space** and constitutes an **element of shading**. The 3-bedroom apartment, which most meets the needs of households, is a **spatial module of 3.00 x 8.00 (24.00 m²)**, that overlaps the structural module, which allows different responses to various program units.

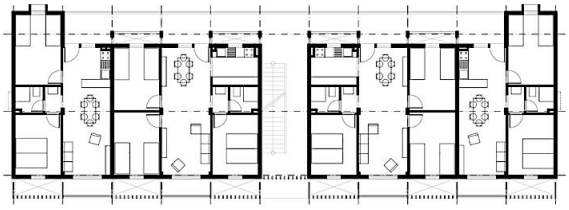
The living-room is the unity's centrepiece, absorbing all circulation spaces and ensuring cross ventilation. It extends to the gallery and to a private balcony on the opposite facade that also ensures protection against direct solar radiation.



G_06 Areas Disposition. [MANUEL, Acácio]

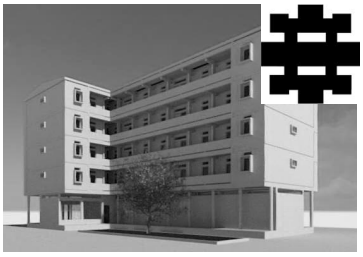
Despite the tiny size of the residence, the living-room holds a dimension adjusted to the Angolan families reality, who meet frequently on weekends. It seeks to reproduce a context of collective housing, a courtyard atmosphere, characteristic of the Angolan *modus vivendi*. The maximum number of floors was defined at five, as the use of elevators is avoided, since the foundations are less expensive and the urban scale is more humanized. The number of apartments varies from 16 to 22 per building, with a single collective entrance and a single staircase, which achieves; shorter construction time and faster availability, construction scale accessible to small and medium-sized national companies, better management of the condominium and lower maintenance costs, better neighbourhood relations and better collective surveillance. The following variations developed;

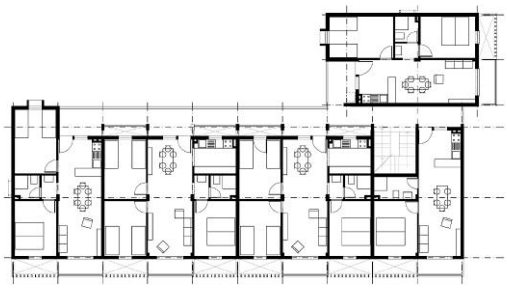
(1) LINEAR BLOCK



F_088 Linear Blocks Dispositions, 3D and Plan. [MANUEL, Acácio]

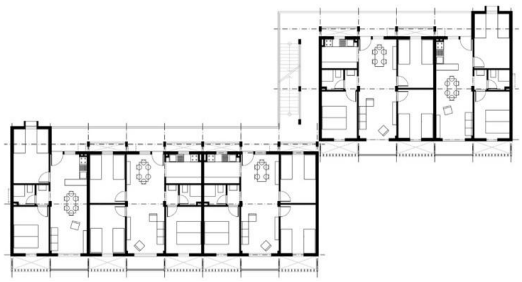
(2) CORNER BLOCK





F_089 Corner Blocks Dispositions, 3D and Plan. [MANUEL, Acácio]

(3) SLIPPED BLOCK



F_090 Slipped Blocks Dispositions, 3D and Plan. [MANUEL, Acácio]

4.3. REGULAR MUSEKE VISIT REPORT BAIRRO OPERÁRIO

"Bairro Operário as an emblematic museke of Luanda, has its history intrinsically linked to the expansion and socioeconomic growth of the city." [free translation - JORNAL DE ANGOLA]

F_091 Bairro Operário Location. [GOOGLE EARTH]

Bairro Operário (1930) was the first urbanized *museke* of Luanda. It possesses a clear urban layout, since its conception, hence the popular name of *"museke without alleys".* According to *Fernando Menezes*, 75 years old, dweller since 1957, the neighbourhood first constructions were built with coconut trees jammed in the soil *"in cans covered with mateba"*. According to *Menezes*, a short time later the towed wood houses were built [SIMÃO, 2014 : 34].

Identified by the *Development Workshop* as an organized *museke*, *Bairro Operário* represents a cluster of degraded buildings with great rehabilitation potential. Since its regular road system facilitates the intervention of new infrastructures.

Throughout the site's visit, it was evident that the *Bairro Operário* - although initially intended to be regular - did not maintain the clear lines of its planning. The buildings expanded and invaded the roads organically - according to personal needs - an inevitable consequence caused by the lack of infrastructure in the foundation of the neighbourhood. Thus, the housing blocks became mutable, some resulting on the expansion of existing constructions and other annexes of new residents. The individual constructions display this diversity, as the houses materials quality vary between cement, wooden and steel-sheets.

The adjacent buildings of the existing houses are generally small businesses that provide various services. This represents the inhabitants predisposition of living in community and working in the neighbourhood, as well as the reality of the common Angolan. Whose the impediment to create own businesses in ordinary conditions - because of the economic disparity - causes the adaptation of the workplace to the place of housing.

F_092 Several small commerce around the neighbourhood. [Author]

The green and recreation public spaces are low represented in *Bairro Operário*. Although the original project plan of its construction, was not available, by the Municipality, it is possible to assume that these spaces would be scarce, due to the urgency of housing units felt at the time. However, in case of existence, any public space would be quickly occupied by illegal constructions. Currently the empty spaces that randomly spread through the neighbourhood - especially at the entrance of *Anangola* Secondary School - are informal buildings that have already been registered and demolished, as families were properly compensated with new properties in the social housing unit, located on the border of the neighbourhood. Following the model of *musekes* requalification, decided by the Master Plan of Luanda.

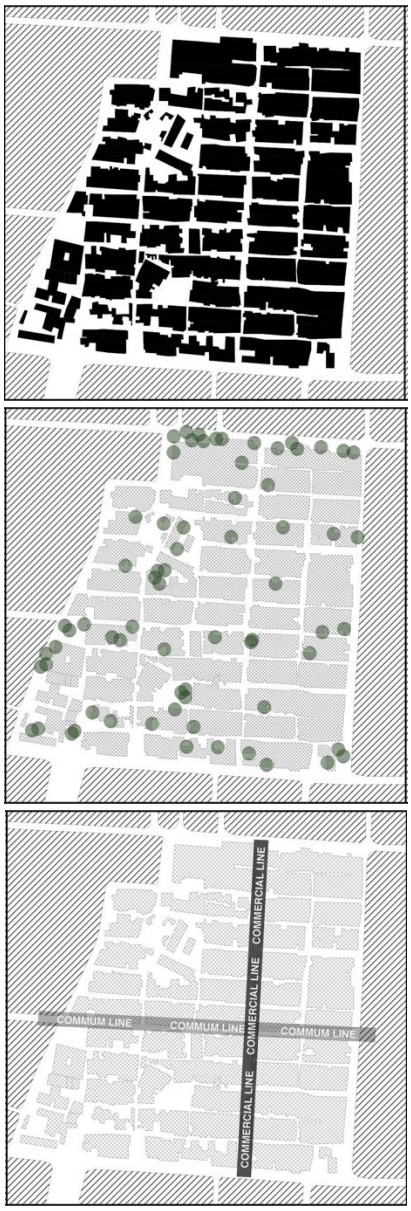
F_093 Social Vertical Residential Complex.[Author]

In order to observe where lays the strengths and weaknesses of the urban and lived spaces, it is performed a quick SWOT analysis, which can characterise the structure and morphology of the neighbourhood. Through this analysis is possible to verify a few problematic areas within the neighbourhood, especially the ones closer to the core, where the lack of regulation is more obvious. There is also a lack of designated public spaces and services for common use, which than translates in the use of the streets – in poor sanitary conditions – for recreation and market trades spots.

Throughout the neighbourhood it was perceived that streets perpendicular to *Cónega Manuel das Neves* street - which delimits the South of *Bairro Operário* - verify a greater concentration of small trades. However the parallel streets are more reserved for housing, deprived of commerce fronts. In this line of reasoning, it would be important to define the perpendicular streets as commercially purpose lines, facilitating access to the neighbourhood – morphologically - through the city. The creation of points of interest that extend through the streets and favour the inclusion of the *museke* with its surroundings.

During the visit, the inhabitants displayed a great distrust of strangers. Unknown people, who question and move around taking pictures, are seen as a threat to their homes. Since the Government has already undergone registration processes, where several houses were demolished, this process though fell short of expectations due to budget cuts. However, the few inhabitants interviewed agreed about the urgency of new infrastructures, when asked about what they would change in the neighbourhood. This would be the ideal starting point for the development of the remaining complementary structures.

Most of the inhabitants worked in the centre, short-term, or owned a small business in front of the house, which constituted the fixed employability. Despite the front of houses being frequently used to stay and cook, most of the time is spent in private backyards, indoors, avoiding excessive contact with the outside.



F_094 Bairro Operário; Morphology, Green Spaces, Commercial and Mutual Lines. [Author]

4.4. IRREGULAR MUSEKE VISIT REPORT RANGEL

"In this neighbourhood, the main road is paved, only to turn on one of the crossroads to enter a muddy road, where old sheds are tinted with graffiti, the stores windows have steel bars and locals are sitting watching the strangers pass." [free translation – DN, 2013]

F_095 Rangel Location. [GOOGLE EARTH]

Rangel is a neighbourhood located in the centre of the City of Luanda, and therefore delimited by organized historical neighbourhoods; *Imgombotas* to the west and *Maianga* to the south. *Rangel* is particular in the heterogeneity represented by the presence of two discrepant morphologies - orthogonal and organic. However, the irregular design stands out because of its proportion, completing about 75% of the neighbourhood, east, following the natural growth of the city. The irregular component defines the expansion caused by the rural exodus - caused by years of armed conflict - that encouraged the rapid and clandestine constructions in the periphery of the old urban centre of Luanda.

Area **6,2 km²**

Population **261 000 inhab**.

Density **42 097 inhab./km²**

Identified by the *Development Workshop* as an *irregular museke* - despite its mixed qualities. *Rangel*'s irregular lineage is associated with the high population density of the neighbourhood - 42 097 inhabitants per km2 – which encouraged the development of blocks of gigantic proportions and inhibited the introduction of sanitation and security infrastructures.

Throughout the site's visit, it was possible to verify a heterogeneous structure, marked by the proximity to the organized urban centre of *Luanda*. The neighbourhood gradually becomes organic in relation to its outline neighbours - to the north, west and south – which are regularized. The organized areas of *Rangel* covers basic sanitation infrastructure - although deficient - since the irregular area located in the east of the neighbourhood, supports the scarcity of the same infrastructure.

F_096 Streets of Rangel. [Portal de Angola]

Unlike many irregular *musekes*, *Rangel* is well-found with several services organization, such as; schools, hospitals, colleges, sport centres, supermarkets, shopping, etc. But these services are part of the regularized territory, where there is no discontinuity with the rest of the city, therefore, neglecting the irregular part of the territory. The lack of planning in the neighbourhood, as a whole, represents a great dimension that discourages urban control. In order to be able to configure and adapt to an orderly common neighbourhood, the existing division of the neighbourhood into sub-divisions would have to be reinvigorated.

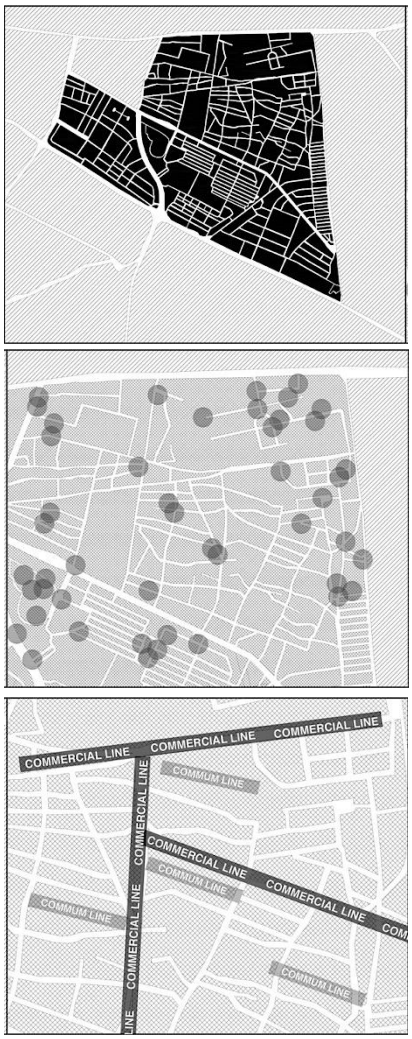
Marçal; organic *museke* with regular compliance, consequence of existing extension of city lines, form diversity of large blocks.
Rangel; irregular *museke* in its entirety with blocks of gigantic proportions represented in various forms.
Vila Alice; Historical district with infrastructures, does not represent urgency of intervention.
Cés de Baixo; district with a regular presence, nameless streets marking, delimited to the north and to the east by vertical constructions.
Terra Nova; regular, except of irregular forms to the west, marked by large factories, to the south.

F_097 Rangel; District Sub-divisions [Author]

The individual constructions are stimulated by population density, since the developed rapidly close to regular buildings - with the initial aim of maintaining the same conformity - but the lack of municipal control led to the construction of extremely dense blocks with unusual dimensions and configurations, which the only access to the core is done through narrow alleys. Quality of life is tested, and the only way to restore it, is to rehabilitate the whole neighbourhood, creating new streets that regulate circulation, which also facilitate the introduction of infrastructure. Alike other *musekes*, the stores adjacent to the dwellings are also quite common in *Rangel*. However, the contact between trades - located in the nucleus of the irregular *musekes* - and the pedestrians is quite sloppy. The access to *musekes* are not appealing, due to a lack of clear reading through the main streets, which makes the trades, only useful services for neighbourhood residents.

Rangel represents a massive and dense cluster, where, with the exception of a few traffic roads - *Tunga Ngo Street* [to the east, *Musekes* Railway Station], *Av. Hoji Ya Henda* [downtown] and *Rua Deolinda Rodrigues* [south] – that divide the neighbourhood and allow internal circulation. The irregular fraction is marked by streets of organic conformity that make up enormous blocks.

The green spaces identified, in the neighbourhood, are of private origin, belonging to backyards and public facilities, such as the courtyard of the *Américo Boavida* Hospital and the surroundings of the *Cidadela* stadium. Due to the high density of construction, there's a lack of public open spaces [green or not] for recreation and air renovation, indispensable for *Luanda*'s tropical climate. In the irregular case the introduction of commercial lines should be selected close to the main delimitations of the neighbourhood, facilitating access from the outside to the interior. Mutual lines would be interior spaces on each block, reserved for its residents.



F_098 Rangel; Morphology (full-empty analysis), Green Spaces, Commercial and Mutual Lines [Author]

4.5. RESULTS

The visit to the Rehabilitation Centre of *Sambizanga* allowed an insight on the practices done currently, by the Government of Angola, to control the actual urgent state of the *musekes* in Luanda. The irregular *musekes* are defined as the most critical areas to intervene, firstly because its proximity to the centre is convenient - since the urgency of rebuilding the urban centre - and secondly because irregular settlements represent the highest urban density of Luanda.

The city of Luanda has a severe scarcity of public and recreational spaces for common use, this is a consequence of its rapid occupation due to the rural exodus, during several years of military conflict. Therefore, the urban layout represents a duality of two realities, the centre – planned – and the periphery – unplanned. The unplanned city – *musekes* – were built under insufficient knowledge – by people themselves – resulting in problematic areas with severe sanitary conditions. The solutions being implemented by the GTRU are motivated by relocating the people living in *musekes* to new centralities – township settlements. The problems related to the township settlements where addressed in a previous chapter [1.3.2], but the study accomplished by the *Development Workshop* is from 2005, and currently these centralities are better equipped with services, and improved road network systems. However, it's great distance to the urban centre maintains the mobility issues concerns.

The uncontrolled reality lived in *musekes* - that allow people to built their own houses and to start small businesses freely - is abruptly lost once the relocating process is completed to the new housing centralities. Further the complexity of proving the legality of houses and licensing informal commerce will leave a large majority of people shortened of a proper compensation, which would inevitably lead to displacements.

Since there is a notorious resistance by the population in maintaining the residence close to the centre, the in-site upgrading - improving the existing infrastructures and rebuilding the degraded constructions – would be an optimum solution. Thus, following the principles of; minimum functional and construction areas, cost restrictions and regulation implementation – according to the *2014* PDL - defined by the GTRU, and so, inciting governmental aid.

To conclude, despite of sharing many of the obstacles, the orthogonal layout of regular *musekes*, facilitates the concept of in-site rehabilitation, on the opposite, the irregular *musekes*, which organic layout presents greater issues related to accessibility, circulation and urban density, that would demand a higher amount of demolition and planning in the process of rehabilitating the current structure. For that, both cases require different approaches, that are further developed in chapter [4.3].

0.5. CASE STUDY ANALYSIS

5.1. REGULAR CASE BAIRRO OPERÁRIO

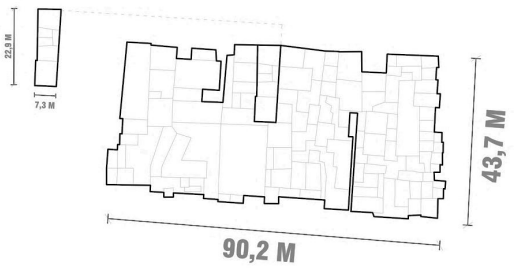
According to the Urban Rehabilitation Office of *Sambizanga* and *Cazenga*, the first phase of the restoration process of *musekes* is the registration of houses and families and the **MUSSUS** programme defends this process. However, the **MUSSUS** programme also aspires to promote in-site slum upgrading, so idealistically would not follow - the remaining steps of the governmental actions - of relocating the people to township settlements. The regular *musekes* of *Bairro Operário* represent one of the greatest potential for in-site slum upgrading, in Luanda, since already displays its streets in a orthogonal urban layout.

In order to create further awareness, in society, of the environmental crisis, the programme promotes the concept of passive design in architecture, along with the concept of recycled materials for construction and the cooperation among the families of the neighbourhood, in other to build and maintain its community. To promote the drawing of each family singularly, we introduce the **MUSSUS** form.
After choosing a block and house, this procedure was then simulated with the Fragoso family.

F_099 Bairro Operário; Photographic Elevation, Outline of the Selected House. [Author]

The elected block is located in the lower left corner of *Bairro Operário*, third in the left-right direction and the second in the bottom-up. Distant from the *museke*'s core, this block represents a great potential in creating transversal lines with commerce fronts. Since the houses must be partially or entirely demolished, in order to adapt the new constructions, there must be located unoccupied sites in the neighbourhood that would stablish an auxiliary structure to house the families while the rehabilitation process is ongoing. This structure, is expected to have around six or more apartments that would shelter families gradually. The function of this construction may be changed eventually, when no longer relevant, to a public service equipment.

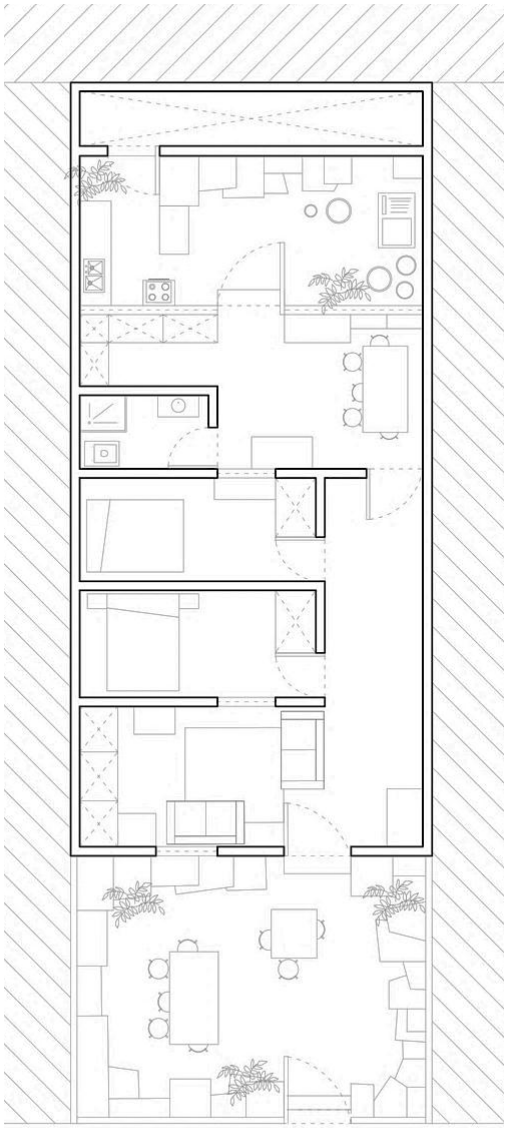
F_100 Bairro Operário; Block Development. [Author]



F_101 Bairro Operário; Block Interior disposition. [Author]

The excessive use of annex constructions to the original planned structure, translates in a lack of clarity of the blocks definition. However, the dimensions of each property was roughly verified, and each house is around 22.9 metres deep and 7.3 metres wide. Excluding few houses that have two-times the size of the front, 15 metres wide, maintaining the same depth of 22.9 metres. The selected model is the 38 House in C Street. The house is embraced by two patios, back and front, and consists of; a living room, two bedrooms, a kitchen and a bathroom.

5.1.1. THE HOUSE DESIGN



F_102 Bairro Operário; Existent Plan of the 38 House . [Author]

The open exterior spaces – patios - are an appealing concept to the *museke's* residents, however, the existing patio spaces are confined to the daily tasks, that replete them of objects and functions. These same courtyards are covered by simple metal plates - avoiding direct radiation - in an attempt of creating shadow. Yet, the placement of the opaque object - metal sheet - at such a low distance from the floor, creates the sensation of a dark tight space. In addition, does not improve the thermal comfort, as the crossed air circulation is hampered. The proper use of the patios is essential to ensure good thermal performance, and in this context the poor use results in tight, dark, and warm spaces. The covered patios of the neighbourhood are attached to the concept of what would be a conventional house, as this is not a singular problem, and defines the norm lived in the *Bairro Operário*. Therefore, the population do not have the perception of different structures, so the issue remains unquestioned.

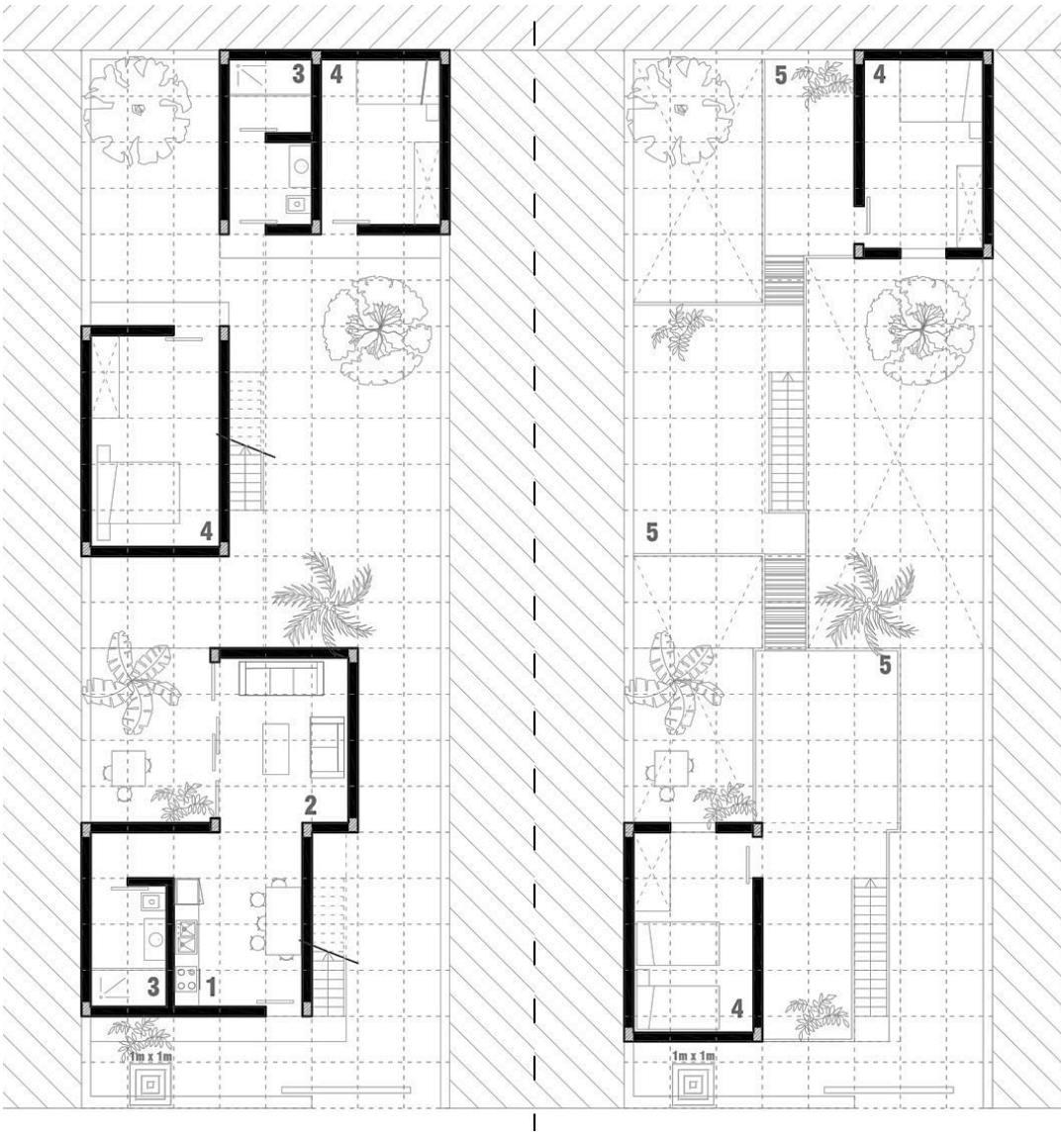
At the beginning of the **MUSSUS** programme simulation process with the *Fragoso* family, during a conversation, it was possible to explore the family's desire to have a better house in a better neighbourhood. [complete questionnaire in the appendix]

The house sketch through the **MUSSUS** form was satisfactory. However, the people's comprehension associated with modular architecture and sustainability awareness was not as straightforward. This, though, reveals the programme potential in creating conscious mindsets, encouraging the individual and community influence in refurbishing the lived space. Thus validates the relevance of the programme, since it delineates positively; the importance of common public spaces, the commercial zones adjacent to the main houses, the diversity in the construction of the dwellings, the patio use preference and the planting of goods, which were all concepts described, by the inhabitants, as important traits of their lifestyle.

The most commented issue was the scarcity of infrastructures in the neighbourhood, mainly, basic sanitation paved roads, and public illumination. The difficulties experienced in the house are consequences of the neighbourhood's structural problems, such as the scarce distribution of piped water, the constants electricity failures and a faulty sewage system. With the introduction of these indispensable systems, 50% of neighbourhood rehabilitation is guaranteed, empowering the population to contribute with the rest.

The acknowledgement of the MUSSUS process were well received, and with my assistance, it was possible to design the structure of a new house guaranteeing the characteristics described by the owner and the rest of the *Fragoso* family;

- Two-story construction
- A big kitchen area connected to the living-room
- Private patios
- 4 bedrooms
- At least 2 bathrooms



[1] kitchen
[2] living-room
[3] wc
[4] bedroom
[5] terrace

*scale: each square represents a square metre

F_103 Bairro Operário; 1st and 2nd Floor Plans of the Mussus Simulation (left-right). [Author]

F_104 Bairro Operário; Model Front View. [Author]

F_105 Bairro Operário; Model Window View. [Author]

F_106 Bairro Operário; Model PatioView. [Author]

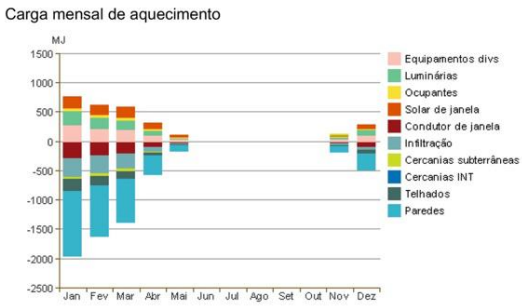
F_107 Bairro Operário; Model View from Room. [Author]

F_108 Bairro Operário; Model Living Room. [Author]

5.1.2. SOFTWARE ANALYSIS

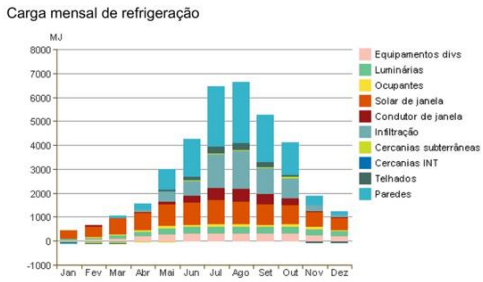
Trough Autodesk Revit, precisely ECOTECT, it was generated an energetic analysis report revealing the energy consumption of the construction. The full report is available in the appendix, since the most important graphics to be analysed are the monthly heating and cooling load charts;

The **monthly heating load** chart analyses the heat loss of each construction element throughout the year. The elements represented bellow the zero mark are defined by the greatest heat loss. Which is a positive result for the construction of the Fragoso family house, since the walls and roofs define the majority of the exposed area. That means that those elements are not maintaining the heat gained during the day, mostly because of the low absorptivity properties of the chosen materials, and the openings in the walls. The higher heat gain impact is the direct solar radiation through the windows, which can be easily improved with shading systems, that were not included in the simulation process.



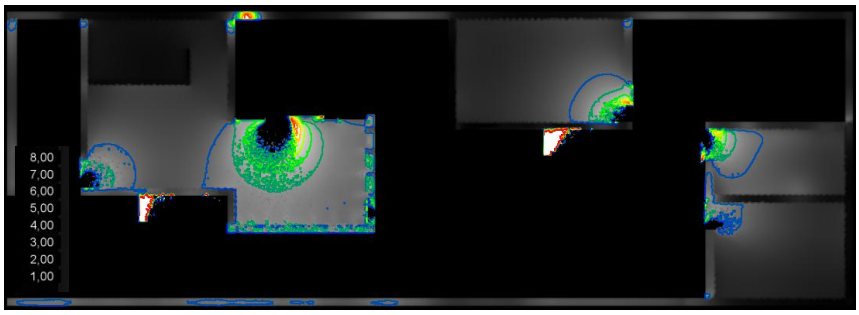
G_07 Monthly Heating Load Chart. [REVIT]

The **monthly cooling load** chart analyses the need of cooling of each construction element throughout the year. The heat energy gain of each element are defined above zero, and the most affected elements are the walls and windows. This chart is a fair representation for the semi-arid climate experienced in Luanda, and shows that the perforated walls are an insufficient element to guarantee the thermal comfortability during the hottest days. However, shading systems, weren't used in the simulation process, which can positively impact the performance of the cooling performance. Especially the introduction of tress and greeneries, that are excellent in shading the walls while improving air circulation.

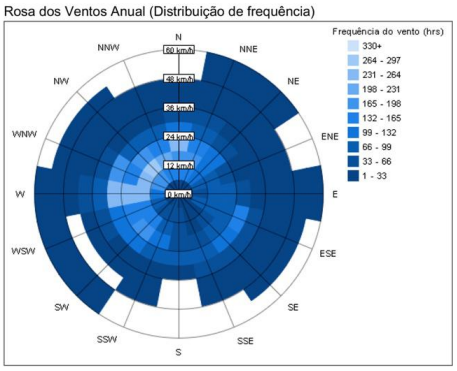


G_08 Monthly Cooling Load Chart. [REVIT]

According to the results it was corroborated that the cooling systems presented by the perforated walls, demanded less use of active design techniques, such as air conditioning. To further analyse the incidence of radiance inside the building, trough VELUX, a plan image was produced displaying the lux levels inside, as represented in the following image, the interior of each compartment transmits a valid performance according to the design, since the doors and windows permit more radiation entry. [The red lines (factor 800 lux) are present in the exposed areas, the green lines (factor 500 lux) are the openings, and blue lines (factor 200 lux) the cooler temperature.]



G_09 ISO contour diagram of daylight incidence. [VELUX]



G_10 Annual Rose Wind Frequency. [REVIT]

The night ventilation simulation was not executed, since the most critical period of the semi-arid climate is during daytime, as the sunlight exposure increases the temperature indoors. However, analysing the wind rose of predominant winds, is possible to verify that they are equally spread throughout all the orientations, thus guaranteeing that perforated walls oriented - north, south, east or west – have a good performance of air renewal through cross ventilation. [The results of the REVIT Software do not consider a series of passive strategies such as; nocturnal ventilation, evaporative heating and other types of ventilation and shading systems that would result in a more substantial reduction of the final consumption results of the energetic analysis.]

5.1.3. CONSTRUCTION COST

One of the **MUSSUS** programme requirements is to guarantee the construction low cost, the prices of prefabricated building materials were surveyed in the Angolan market, through an online budget simulator - CYPE. As a result, it was possible to evaluate the cost of production - 6 767 080, 63 kwanzas, about 25 153,35 euros (conversion xe.com). Alluding that the costs of demolition, transport, labour, and any additional cost required were excluded.

	m²	custo / m²	total
superficial foundation	16	11 992,02 (aoa)	308 535,04 (aoa)
structural module	7	*un ~ 251. 232,16 (aoa)*	1 758 625,12 (aoa)
concrete pavement	67	5 385,00 (aoa)	360 795 (aoa)
masonry	276	13 881,80 (aoa)	3 831 376,80 (aoa)
stairs structure	8	1 232,78 (aoa)	9 862,24 (aoa)
steps cover	13	8 419,01 (aoa)	109 447,13 (aoa)
bridge structure	4	1 231,74 (aoa)	4 926,96 (aoa)
structural slab	67	8 419,01 (aoa)	383 509,34 (aoa)
		6 767 080,63 (aoa)	

T_13 Bairro Operário; Fragoso Family House Structure Simulation Budget. [Author]

Thus other components, such as ground levelling, introduction of sewage, rainwater, electricity and gas networks, etc. - these features were omitted from the budget due to lack of available information on the manufacture and local price of the complementary elements.

5.1.4. REGULAR MUSEKE LINES OF INCLUSION

The orthogonal display of the streets demarcation and typologies – Commercial Line and Mutual Line - will be decided through the population common needs. In the Regular Case – *Bairro Operário* - its representation will maintain the perpendicular lines, later defining its function, as commercial lines can encourage the circulation between the city and the neighbourhood.

F_109 Diagram: Commercial and Mutual Streets. [Author]

The Commercial Line are streets intended for stores and markets, enabling spontaneous commerce, however establishing awareness of legality, assisting the people rightfully with licenses and permits to perform this labour. This aid, from the Government, would express a willingness to respect and to correct the informal commerce dilemma.

F_110 Commercial Street Simulation Render. [Author]

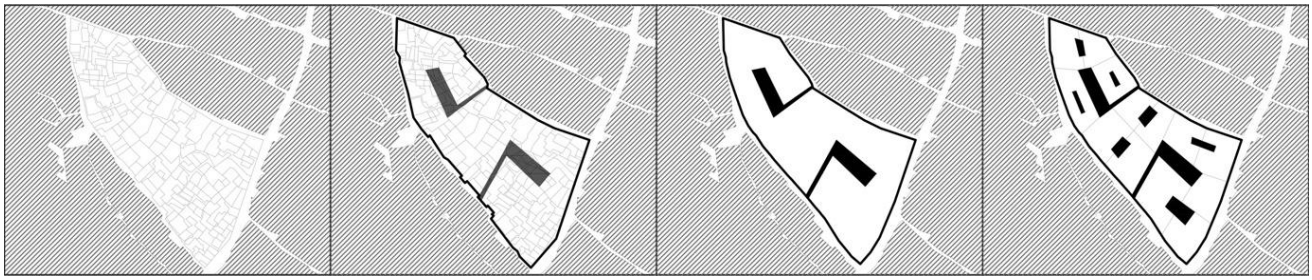
The Mutual Line are streets intended to award individual talents of the neighbourhood community. These would be streets associated with recreation and green spaces, as well as street artwork that can upgrade any excluded precinct. The street art is usually connected to the communities in need, which transform the way the others see their community, and reinforces their emotional connection to their living space. This is a similar approach as the rehabilitation done in the social housing neighbourhood "*Quinta dos Mochos*" in Lisbon. This intervention reduced the criminality and exclusion, while promoting the neighbourhood's daily visiting from others outside the area and tourism.

F_111 Quinta dos Mochos by Vhils. [JR, 2014]

F_112 Mutual Street Simulation Render. [Author]

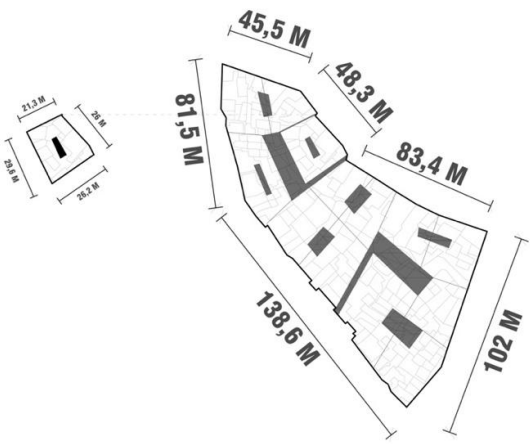
5.2. IRREGULAR CASE RANGEL

My visit to the irregular case of study – *Rangel* - did not allow a better understanding of the living spaces inside the houses, due to the a great distrust of strangers by residents. This is a consequence of the closed morphology regarding the exterior, so most of the daily tasks are done in the neighbourhood and the services needed are created in order to overcome the lack of benefices. Nevertheless, it was not possible to collect interviews from inhabitants, nor to simulate the process of drawing a house with a selected family. Despite the unforeseen circumstances, it was possible to select a block of intervention, and its demonstration was done without intermediaries. The chosen block is located near the *Rangel* nucleus, fifth in the right-left direction (*Tunga Ngo* Street).



F_113 Rangel; Block Regularizing Development . [Author]

The block proximity to *Rangel*'s core represents a great potential in the possibility of extending the streets – to the inside of the *museke* - with commercial fronts. The houses have different dimensions and the irregular dispositions difficult the precision in figuring the amount of apartments or families living in the block. In order for the change to be practical and effective, it is expected to maintain the general shape of the block, though regularized, enlarging the street that surrounds it and creating two block entrances, leading to an interior public patio, which would promote cross ventilation between buildings, while also forming an open public recreation space for the residents.

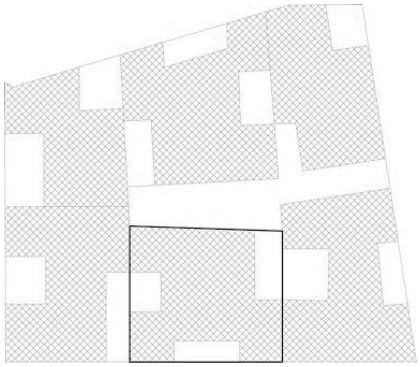


F_114 Rangel; Block Interior Development . [Author]

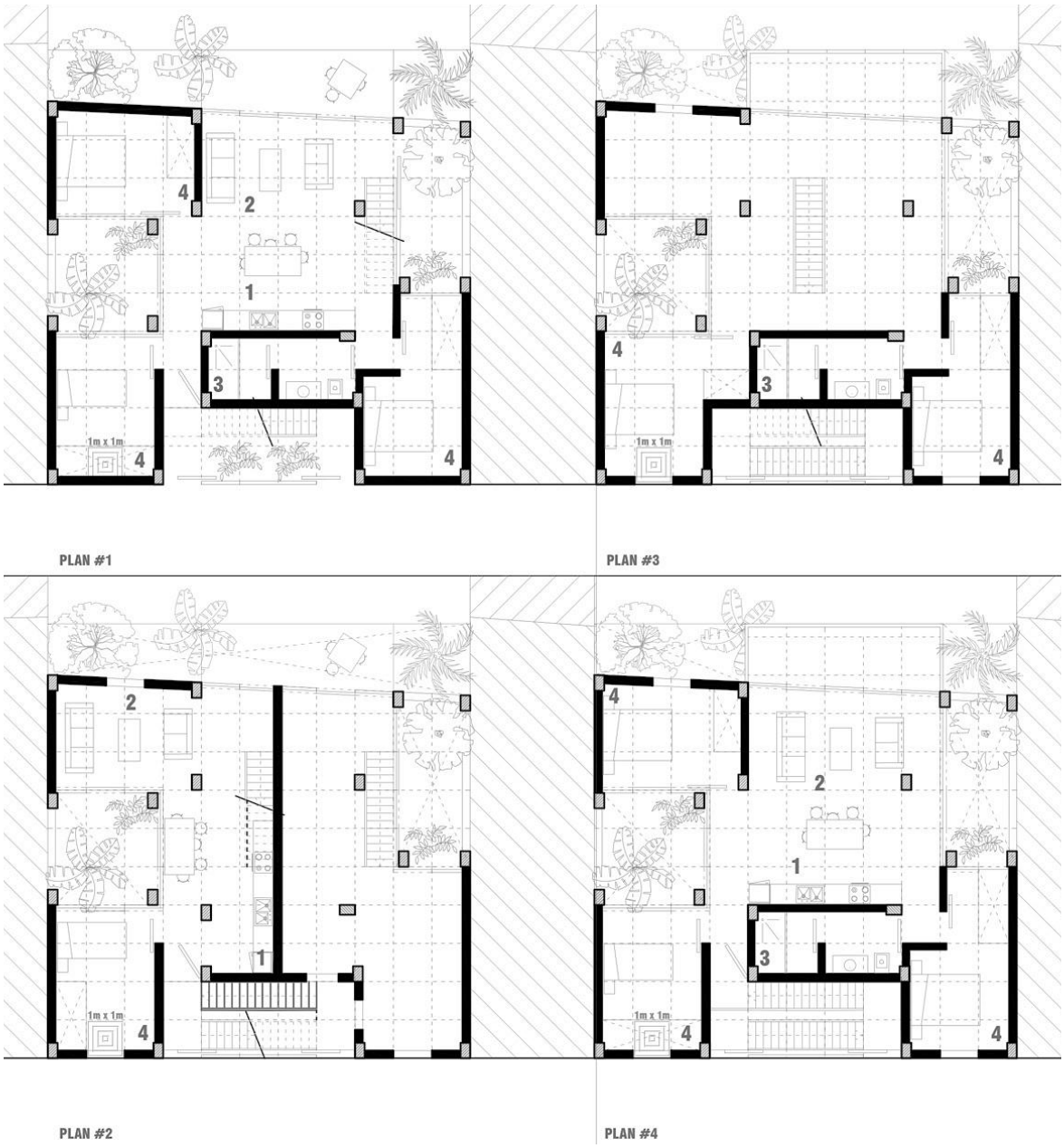
The **MUSSUS** programme supports that the solution to improve the populational density crisis of irregular *musekes* – which is higher than the regular *musekes* - is to develop several vertical constructions. As verified by the Rehabilitation Centre in *Sambizanga*, vertical constructions compensate for the lack of public and private space in the urban layout of irregular *musekes*, which affects the ratio inhabitant per km^2. As already reviewed by the GTRU public entity, social housing in Angola is stipulated to maintain a rule of **12 m^2 per person** and a budget limit of **32,822.84 (eur) per four bedroom apartment** (T4). Ensuring these boundaries the MUSSUS programme for irregular *musekes* developed the following solution simulation.

5.2.1. THE HOUSE DESIGN

The block is divided into sub-blocks, housing 3-4 vertical housing units, with the limit of 4 floors per building, for the same reasons defined previously by the GTRU. The 1st floor and half of the 2nd floor form an apartment (up to < 6 bedrooms), the other half of the 2nd floor and the 3rd floor form another apartment (up to < 6 bedrooms, and occasionally 4 bedrooms). The programme proposes to lay the structure, building about 1/3 to 2/3 of each apartment, relying in an evolutionary system, as the remaining construction would later be completed by the residents, as referred in the *Quinta Monroy* case study [2.1.1]. The purpose of the simulation held for a house in the irregular *museke* of *Rangel* was to accommodate 3 large families. The selected site has an area of 22m² - 11 metres wide and deep - excluding the courtyards and public areas. The main objectives were to adapt interior patios into all the floor areas, that promotes cross ventilation and improves natural illumination during the daytime



F_115 Sub-block Dispositions. [Author]



[1] kitchen
[2] living-room
[3] wc
[4] bedroom
[5] terrace

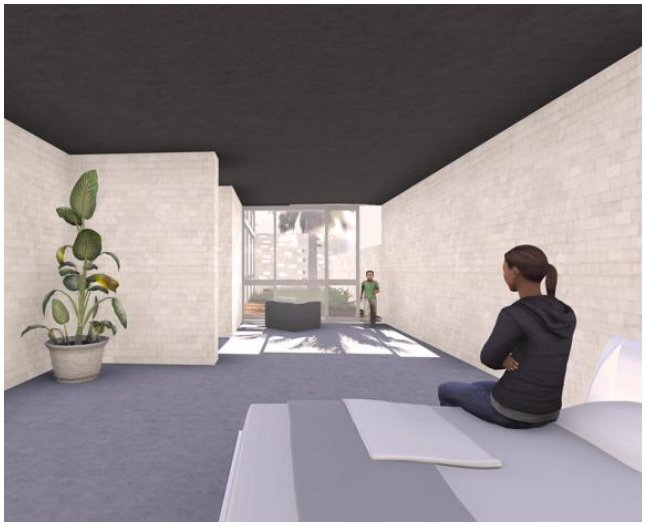
*scale: each square represents a square metre

F_116 Rangel; House Plans.[Author]

F_117-118 Rangel; Common Patio View. [Author]

F_119-120 Rangel; Model Interior Private Patio View. [Author]

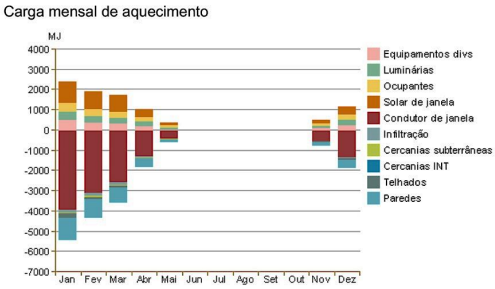
F_121-122 Rangel; Room Patio View. [Author]



5.2.2. SOFTWARE ANALYSIS

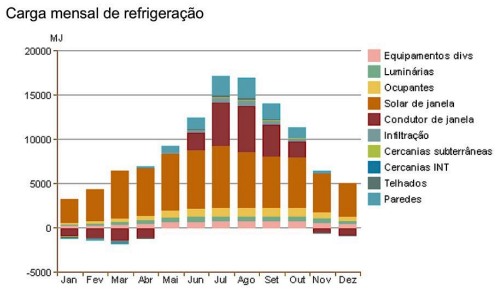
Trough Autodesk Revit, precisely ECOTECT, it was generated an energetic analysis report revealing the energy consumption of the construction. The full report is available in the appendix, since the most important graphics to be analysed are the monthly heating and cooling load charts;

The **monthly heating load** chart analyses the heat loss of each construction element throughout the year. The elements represented bellow the zero mark are defined by the greatest heat loss. Represented in the irregular case by the windows and walls as they define the majority of the exposed area. That means that the windows are the most exposed area to sunlight. However, they are not maintaining the heat gained during the day, since the adjacent buildings to the inner patios are providing shade.



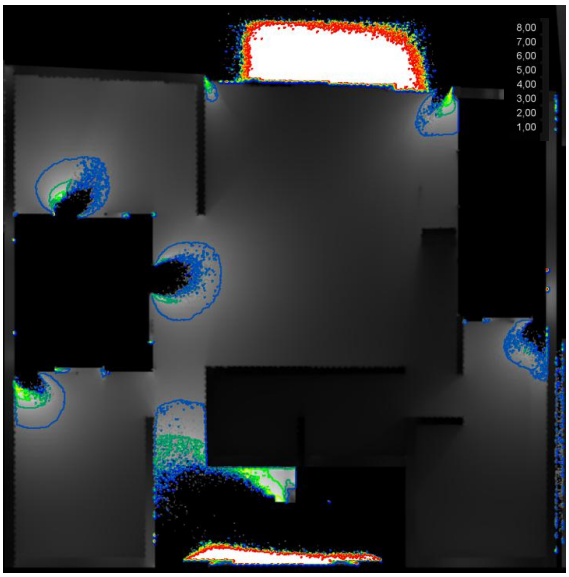
G_11 Monthly Heating Load Chart. [REVIT]

The **monthly cooling load** chart analyses the need of cooling of each construction element throughout the year. The heat energy gain of each element are defined above zero, and the most affected elements are the windows, during the summer months. In this case the perforated walls are a sufficient element to guarantee the thermal comfortability during the most heated days. Mostly because in the vertical reality, the adjacent buildings provide extra shading to the exposed areas of the building. So, especially the lower floors, can maintain a fair coolness during the day.



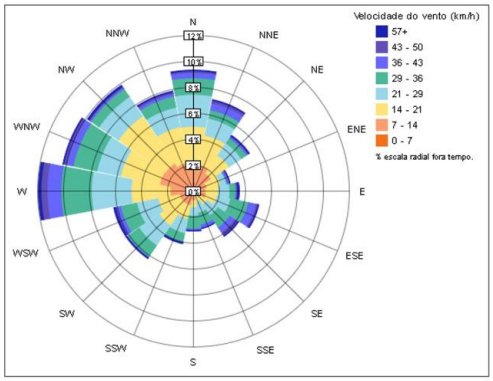
G_12 Monthly Cooling Load Chart. [REVIT]

According to the results it was corroborated that the cooling systems presented by the perforated walls, demanded less use of active design techniques, such as air conditioning. An daylight occurrence was held, trough VELUX, and the areas with higher radiance incidence are the non-shaded areas as the balconies and entrance stairs. Nevertheless the rest seem to corroborate the expected performance of the drawing plans. [The red lines (factor 800 lux) are present in the exposed areas, the green lines (factor 500 lux) are the openings, and blue lines (factor 200 lux) the cooler temperature.]



G_13 ISO contour diagram of daylight incidence. [VELUX]

Rosa dos Ventos Anual (Distribuição de velocidade)



G_14 Annual Rose Wind Velocity. [REVIT]

The night ventilation simulation was not executed, since the most critical period of the semi-arid climate is during daytime, as the sunlight exposure increases the temperature indoors. However, analysing the wind rose of wind velocity orientation, is possible to verify that the wind coming from the west achieves a higher velocity, as west-north orientation receives the highest velocity range. Consequently, perforated facades oriented west-north can guarantee a better performance of air renewal through cross ventilation. [The results of the REVIT Software do not consider a series of passive strategies such as; nocturnal ventilation, evaporative heating and other types of ventilation and shading systems that would result in a more substantial reduction of the final consumption results of the energetic analysis.]

5.2.3. CONSTRUCTION COST

Ensuring the low cost of construction, is one of the requirements to guarantee the validity of the **MUSSUS** programme. For this, prices of prefabricated building materials were surveyed in the Angolan market, through an online budget simulator - CYPE. It was possible to evaluate the cost of production of 17 245 461,28 kwanzas, about 63 751,45 euros (conversion xe.com), mentioning that were excluded the costs of demolition, transport, labour , and any other additional cost required, such as installation of basic sanitation networks. These systems are integrated in the neighbourhood, that is, on a larger scale, making it impossible to verify their costs due to the insufficient information available.

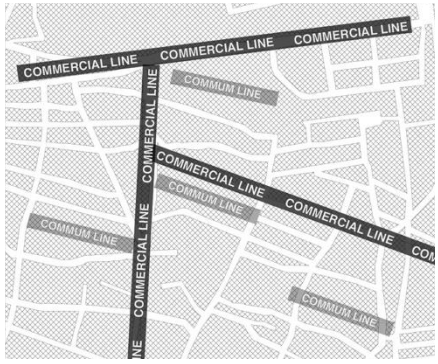
	m²	custo / m²	total
semi-deep foundation	121	11 992,02 (aoa)	1 451 034,42 (aoa)
structural module	24	*un ~ 251. 232,16 (aoa)*	6 029 571,84 (aoa)
concrete pavement	80	5 385,00 (aoa)	430 800 (aoa)
masonry	504	13 881,80 (aoa)	6 996 427,20 (aoa)
stairs structure	25	1 232,78 (aoa)	30 819,5 (aoa)
steps cover	34	8 419,01 (aoa)	286 246,34 (aoa)
structural slab	240	8 419,01 (aoa)	2 020 764,4 (aoa)
			17 245 461,28 (aoa)

T_14 Rangel; House Structure Simulation Budget. [Author]

As defined by the *Sambizanga* and *Cazenga* Rehabilitation Office, the construction simulated by the **MUSSUS** programme respects the maximum area restrictions (12 m² per person) - **100 m² for a family of 8 people (12.5 m² per person)** - and general budget (32,822.84 (eur) per apartment) - **the partial estimate of 21 250.48 (eur) per apartment**, considering the **MUSSUS** programme advantage in assuring 6 rooms, instead of 4 rooms.

5.2.4. IRREGULAR MUSEKE LINES OF INCLUSION

The irregular *musekes* represent an enormous challenge in solving the slums crisis in Luanda. Since is mandatory to destruct a great amount of the urban fabric, in order to create new public spaces, re-shape the streets infrastructure and rebuild new housing arrangements. Taking that into consideration, it is also relevant to maintain the organic volumetric shapes thereby protecting its identity. So the actual irregular shapes can be regularised, avoiding extra costing in planning and rebuilding.



F_123 Diagram: Commercial and Mutual Streets. [Author]

In the definition of the commercial and mutual typologies [chapter 4.1.3], is important to - in the irregular case - to conform the neighbourhood blocks. The block would embrace two inner public patios, further each sub-division of the block would embrace an inner semi-private patio, and finally each housing division would be defined by inner house patios. These definitions are created to promote the ideals of the passive design, explained previously, as well as to configure more common open spaces, vital to improve the quality of life in the *Rangel* neighbourhood.

The re-drawing of the blocks do not need to be orthogonal or four-sided, however, is necessary to impute regulations, in order to facilitate pedestrian and car circulation, favouring inclusion all-around. The Commercial Line, as well as the blocks, should accommodate green spaces, which can moderate local microclimate, lowering temperatures up to minus 10º Celsius, according to *Green Vitruvius* (2001 : 52). This is also the perfect strategy – green public spaces and streets with commerce fronts - to connect a city-wide network as verified in chapter [4.1.2] and [4.1.3]. The Mutual Line is the designated place for free creative demonstration of the community talents, since is well-noted that colour and street art can change the way a place is lived and perceived from outsiders.

F_124 Mutual Line inside Public Patio Render Simulation. [Author]

5.3. FINAL RESULTS

The *know-how* presented by the Urban Rehabilitation Centre of *Sambizanga* was critical for the work developed in this chapter. The idealistic solutions of the MUSSUS program met a compromise with the realistic solutions being applied currently in Luanda.

The housing design and energetic analysis for both cases – regular and irregular – further proved the legitimacy – social, sustainable and standardised ideals – of the archetype. However, the other ideals – voluntarism, recycling, self-sufficiency, in-site upgrading and tenure laws solving - of the program remain unverified. Particularly, these ideals are a complex issue to tackle, therefore after an exchange with the experienced professionals of the Rehabilitation Centre of Sambizanga, a question was made.

Is the MUSSUS program conceivable?

The Regular Case | *Bairro Operário*
The registration process of *Bairro Operário* was cancelled due to the State's budget reduction. Which is currently focused in financing the rehabilitation of irregular *musekes*. These *musekes* represent more urgency due to their state of degradation and high population density. According to *Bento Soyto*, architect responsible of the *Urban Rehabilitation Centre of Sambizanga*, this kind of programme - **MUSSUS** - and project – *Fragoso* family house - would be single relevant to regular *musekes*, that are prone to be rehabilitated with more dexterity, since they do not display serious structural problems, when compared to irregular *musekes*. However, it would be advantageous to possibly apply the **MUSSUS** programme to *musekes* outside the capital of Luanda, since the lower population density recorded in the provinces, guarantees more effective results.

The Irregular Case | *Rangel*
To resume, the legality of land ownership in irregular *musekes* is an inherent issue in the propagation of illegal constructions. The solutions used to transform *musekes* in *Luanda* usually involve the displacement of families to peripheral districts. However, the **MUSSUS** programme encourages a different approach, to maintain the housing location, legalise the land and promote *in-situ* rehabilitation. As pointed out by Architect *Ilídio Daio* in a conversation, this process, despite of not being the most appealing solution is a plausible one, since the informal settlements crisis in *Luanda* is extremely critical, and accumulating the economic crisis, the means to enable a transformation are reduced, and the in-site slum upgrading approach makes it a more affordable solution long-term.

5.4. FINAL RECOMMENDATIONS

The process of refurbishment seeks to maintain the population and existing buildings structure, creating conditions for its progressive improvement, in parallel with the infrastructure and qualification of the public space. Even though the apogee of the MUSSUS programme is represented in the regular and irregular cases portrayed in previous chapters, its only reasonable to promote the same ideals in more realistic scenarios of space transformation, which cannot achieve the same economic means. In case of inability in materialise conventional concepts, MUSSUS programme promotes these alternative methods and recommendations for existent structures:

- The buildings external galleries should remain open to perform as a shading system and façade cooling. In case the galleries are closed, the use of clear glass must be avoided because of its absorptivity properties.

- The building openings must avoid east and west orientation, since the sun is at the lowest position, further affecting the exposed areas. The south is the coolest orientation option.

- If the building openings are directed to the east or west orientation, shading systems should be incorporated into the vulnerable openings, improving the thermal performance.

- The shading elements can be horizontal or vertical depending on the direction of the radiation. Screening is a good option and is easily adaptable to windows and doors.

- The predominant wind can be studied in order to adjust the drawing of the house, improving to the maximum the cross ventilation performance.

- The materials used for the construction of new elements should be recycled if possible, otherwise, the use of local materials should be prioritised.

- The exterior of the buildings should be painted with light colours, since they have higher emissivity properties, and are less likely to absorb radiation than darker colours.

06. CONCLUSION AND FURTHER WORK

The purpose of this dissertation is to analyse excluded spaces – *musekes* - in the urban fabric of *Luanda*, and to create guidelines that, in theory, can unite the city as a whole. The current Angolan reality is marked by years of military conflicts, which resulted in a great rural exodus to the capital, which defined the actual informal urban areas of Luanda.

To transform the *musekes* is to alter urban faulty connections. The slums in *Luanda* should be a major concern for the Angolan Government. Solutions for the slums are currently being implemented, however they are not being fast and effective enough to tackle the problem in its urgency and magnitude. The country is in need of unconventional ideas to complement this process. **To upgrade housing in *musekes* is to cultivate new concepts.**

The **MUSSUS** programme embodies a singular concept, the 3 S's – "**S**ustainable, **S**ocial and **S**tandardised". Its design involves self-sufficiency, recycling, community maintenance, domestic agriculture and bioclimatic design. One of the main goals is to bring awareness to environmental issues and problem solving responsibility to the community, changing quality of life significantly. In this context, governmental aid is necessary for this project prosperity, since there are numerous constraints, particularly tenure and economic issues, in transforming an urban territory. Considering this, this thesis shows that the **MUSSUS** design concept is more cost-effective – therefore more achievable - than the current conventional solutions to regulate *musekes* in Luanda.

To build new constructions is not enough to solve the problem of the *musekes*: for that is necessary to comprehend and embrace people's culture and lifestyle. **MUSSUS** is more than just a social housing programme, it aims at creating a movement capable of accepting the uniqueness of a people, regulating and legalising informal commerce, promoting art, creativity and freedom of speech. This process will be aid by upcoming professionals, qualified to help developing new neighbourhood concepts.

The **MUSSUS** final testimony is the re-definition of the *musekes*, allowing people to be involved in the conception of their living space, humanizing the importance of their homes. This process will bring new ideas, new design solutions, inspiring new space configuration and a tangible recommendation plan to existent structures in *Luanda*, and possibly *Angola*.

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APPENDIX

Caso Regular_ Bairro Operário _ Questionário

Início do processo de simulação do programa MUSSUS com a Família Fragoso:

a. O terreno da sua casa foi obtido após ocupação, compra ou com as construções atuais incluídas?
" Herdei a casa dos meu pais."

b. Construiu a sua casa por conta própria, com ajuda de terceiros e sem mão de obra especializada?
"A casa já estava construída, só fiz alteração para ter água canalizada e mudei o telhado, fechei o quintal para não chover dentro de casa. Uns moços do Bairro fizeram."

c. Quando foi a última vez que fez obras na sua casa? Que alteração fez e porquê? *"Foram as chapas no quintal, e o meu filho meteu cimento na entrada, porque entrava muita água e lama da rua durante as chuvas"*

d. Usa o espaço o exterior da sua casa, para alongar o seu espaço de estada? [Ex: para cozinhar, etc]
"Uso a rua para grelhar, e as vezes sentar um pouco e apanhar ar fresco, quando há festa também a fazemos no quintal e na rua."

e. Qual o espaço da sua casa que usa com mais frequência durante o dia? *"Uso mais o quintal de trás para cozinhar e lavar a roupa, também o quintal da frente para grelhar e falar com os vizinhos"*

f. Se pudesse mudar alguma coisa na sua casa, qual seria? [Ex: Nº de Quartos, Área Total da Casa, etc.]
"Eu queria ter uma casa com um andar em cima, com mais quartos, e um quintal privado maior, "

g. Conhece o termo Sustentabilidade? E Arquitetura Modelar? O que entende pelos termos indicados?
"Nunca ouvi falar, não sei"

h. Gostaria de ter uma mini-horta no quintal da sua casa? [Ex: Plantação de mandioca, batata, etc]
"Se a terra fosse fértil sim, era bom plantar batata, mandioca e gostaria de ter uma árvore também."

i. Se tivesse oportunidade, gostaria de construir uma nova estrutura para a sua casa neste mesmo espaço, ou estar envolvida no seu desenho? Porquê?
"Gostava de ter uma coisa melhor do que tenho, se poder decidir algumas coisas melhor."

j. Preferia viver num Bairro com casas iguais ou diferentes? *"Gostaria de ter uma casa só minha, se todas fossem iguais pelo menos a cor devia ser diferente."*

k. Preferia ter um espaço comercial, tipo loja, na sua casa que pudesse usar ou arrendar? Ou prefere trabalhar na cidade? *"Eu já vendi gelado mesmo aqui no quintal da frente, mas agora queria ter só a minha casa, se fosse antes iria gostar de ter uma loja aqui."*

l. Sobre as Novas Centralidades, estaria aberto(a) a viver longe da cidade em novas habitações construídas pelo Governo? Em prédios? *"Muita gente do bairro já foi deslocado para fora, eu não sei como vai ser comigo, mas se pudesse escolher preferia ficar. Gosto do meu quintal, não quero viver em prédios."*

Após Entrega de Formulários;

a. Após breve explicação e leitura dos formulários, compreendeu do que se trata? Conseguiria preencher todas as folhas sem instrução? Considera o entendimento simples ou complicado? Porquê?
"Não é difícil mas não conseguia fazer sozinha, preciso de ajuda, porque tem muita coisa que estou a aprender agora."

b. Após algum acompanhamento, entendeu o processo? Considera que este processo é válido e funcionaria na realidade? Se não, o porquê? *"Acho que sim, mas têm de nos ajudar."*

c. Gostou do produto final? Porquê? *"Sim"*

MUSSUS

[BAIRRO OPERÁRIO]

[BAIRRO OPERÁRIO , STREET C, Nº38]

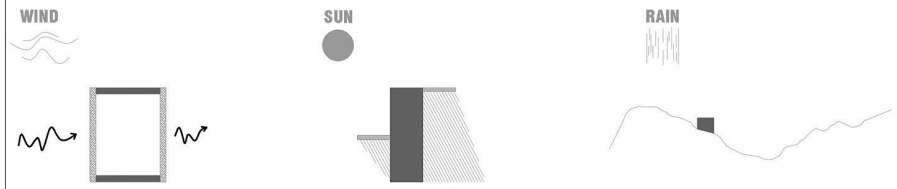
N

FAMILY UNIT [INSERT FAMILY NAME : FRAGOSO]

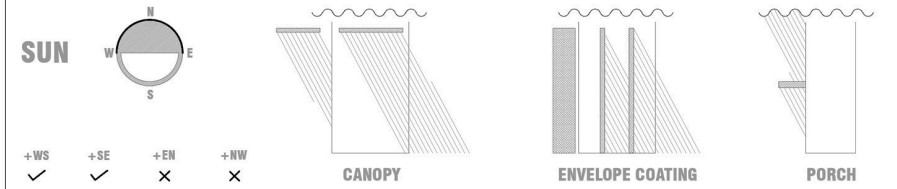
KINSHIP	FULL NAME	AGE	GENDER
mother	Aida Fragoso	60	F
son	Gil Fragoso	40	M
daughter	Solange Fragoso	34	F
son	Helder Fragoso	42	M
son	Carlos Fragoso	30	M
granddaughter	Sana Fragoso	15	F
grandson	Stelvio Fragoso	12	M
grandson	Daniel Fragoso	11	M

DESCRIPTIONS : [INSERT : BLOCK NAME : HOUSE NAME]
[INSERT : DETAILS]

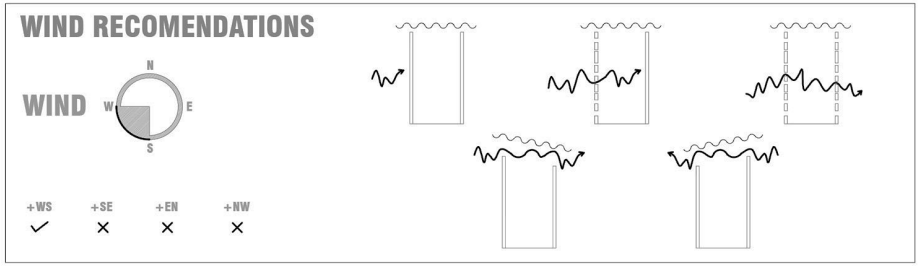
POSITION AND ORIENTATION



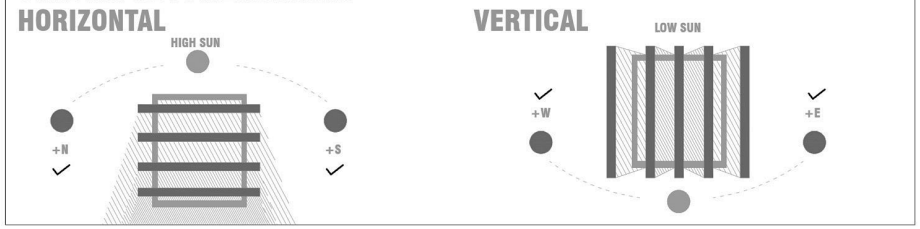
RADIATION RECOMENDATIONS



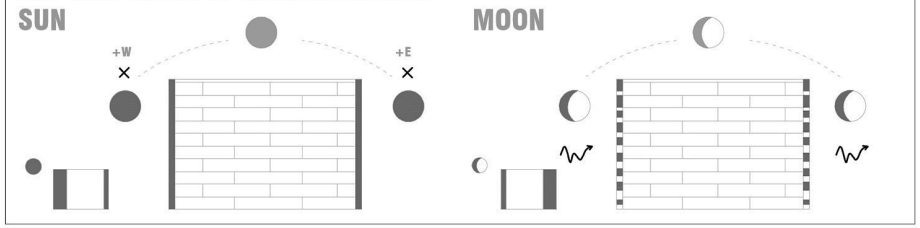
WIND RECOMENDATIONS



SHADING RECOMENDATIONS

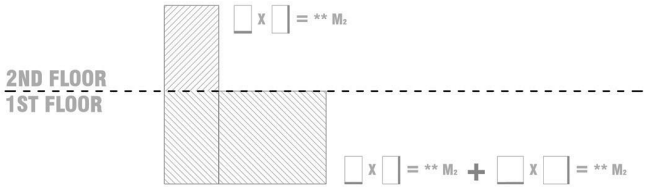


DAY AND NIGHT RECOMENDATIONS



PASSIVE MEASURES

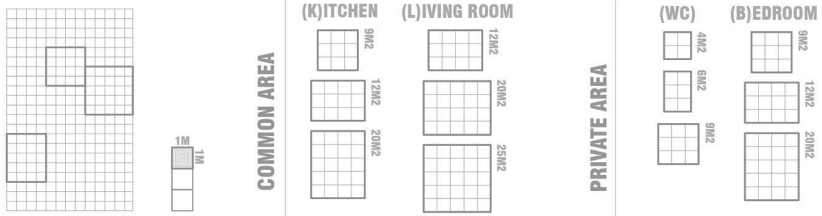
AREA BOUND



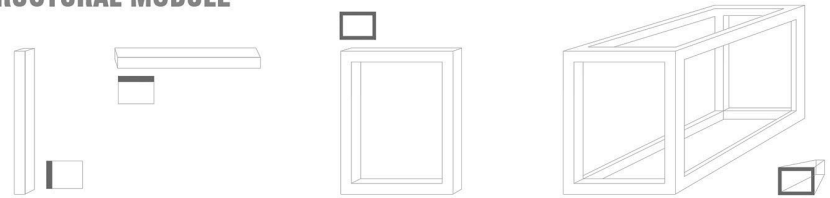
TOTAL MAXIMUM

150 M2 - 200 M2

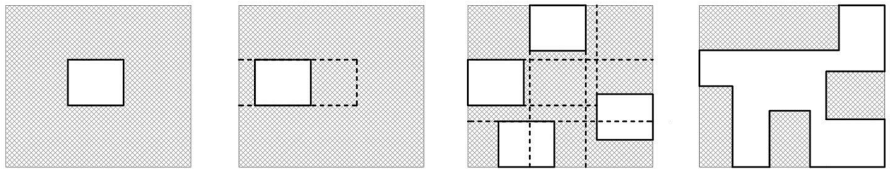
AREA DIMENSION



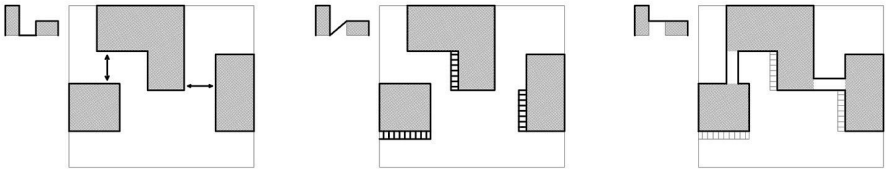
STRUCTURAL MODULE



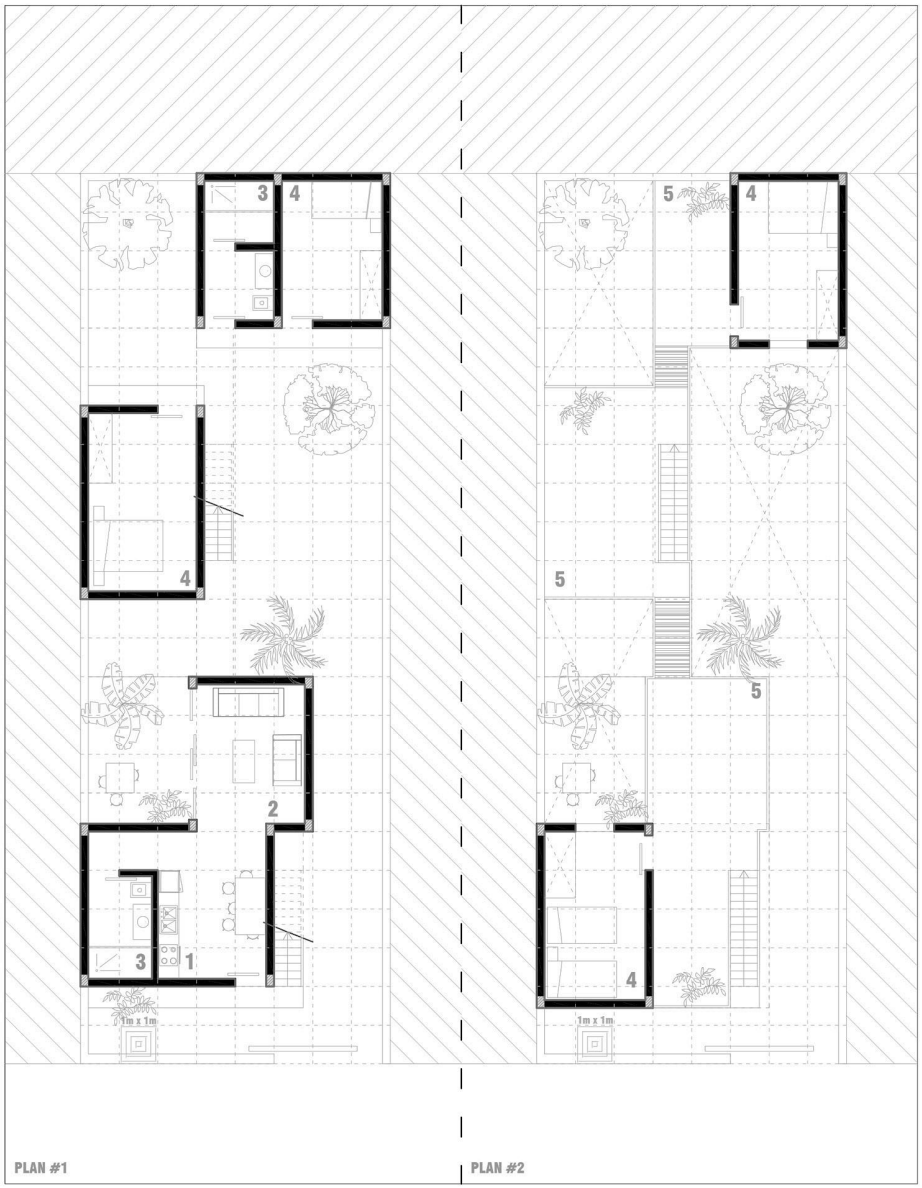
PATIUMS



STAIRS AND BRIDGES

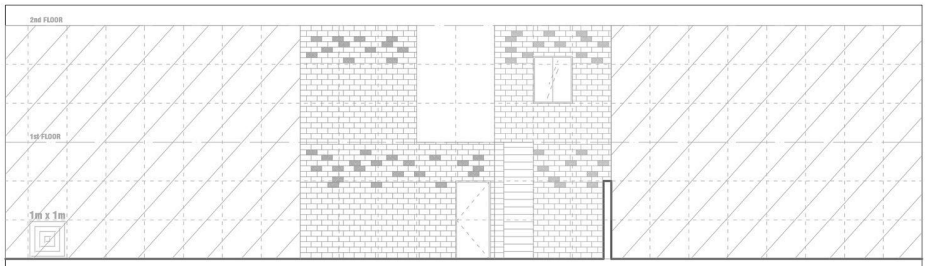


CONCEPT

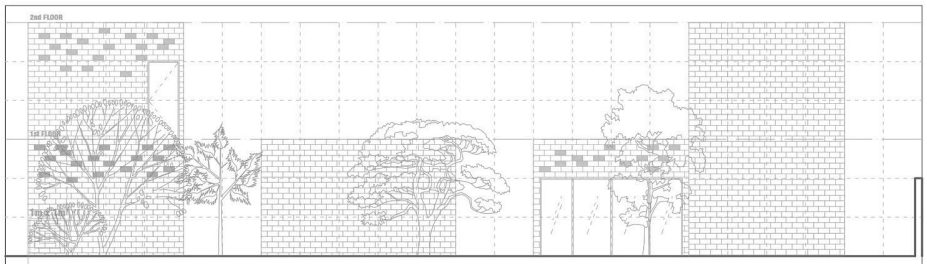


DESCRIPTIONS : [1] KITCHEN
[2] LIVING ROOM
[3] BATHROOM
[4] BEDROOM
[5] TERRACE

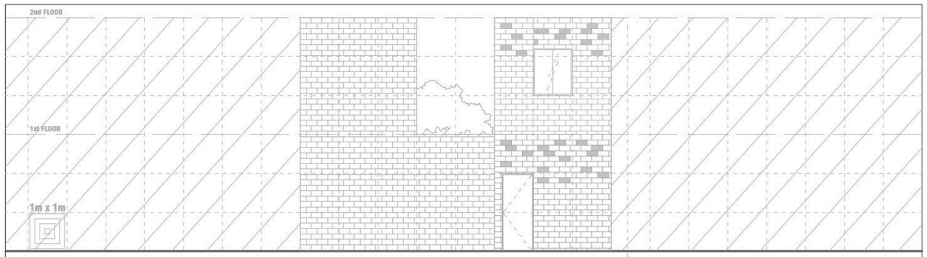
PLANS



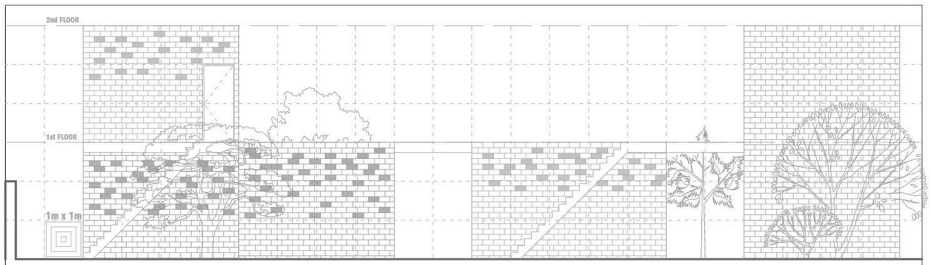
FRONT



LEFT



BACK

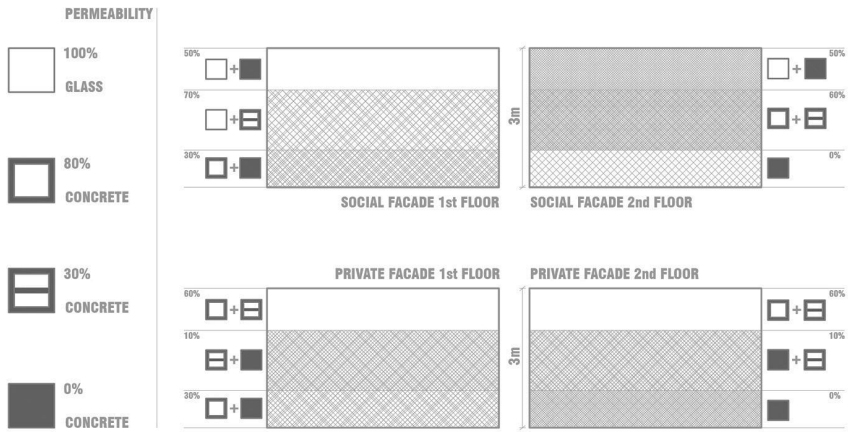


RIGHT

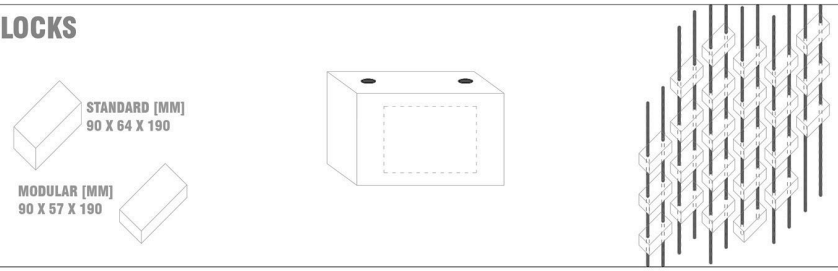
DESCRIPTIONS : [INSERT : DETAILS]

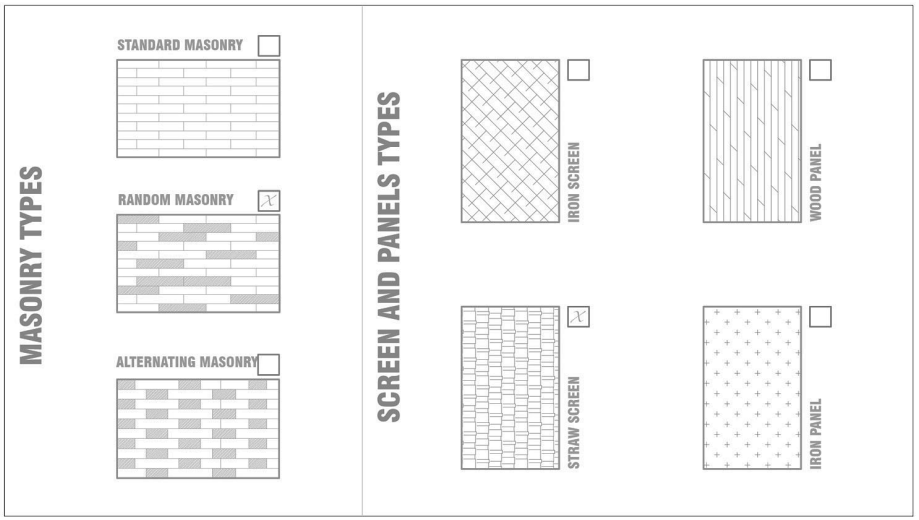
ELEVATIONS

FACADE SCREENING DIAGRAM



BLOCKS





WALL AND SCREENING TYPOLOGY

	LOW-COST		HIGH-COST	
PAVEMENT	CERAMIC	☒	WOOD	☐
BRICK WALLS	CLAY	☐	CEMENT	☒
DOORS	METAL	☒	WOOD	☐
WINDOWS	PLASTIC	☐	GLASS	☒
ROOFS	TERRACOTA CLAY TILES	☐	SANDWICH [METAL, STYROFOAM, METAL]	☒
CANOPY	BAMBU	☐	WOOD	☐
	STRAW	☒	IRON	☐
ENVELOPE COATING	BAMBU	☒	WOOD	☐
	STRAW	☐		
STAIRS | BRIDGES	PERFORATED METAL	☒	CEMENT	☐
BANISTER GUARD	METAL	☒	BRICKS	☐

MATERIALS

	QT.	COST	DSCPT
FOUNDATIONS			
SUPERFICIAL | CONCRETE	M2	(AOA)19.283,44	
SUPERFICIAL | REINFORCED CONCRETE	M2	(AOA)26.984,69	308 535,04 (aoa)
SEMI-DEEP | REINFORCED CONCRETE	M2	(AOA)11.992,02	
STRUCTURAL MODULE	~UND	(AOA)251.232,16	1 758 625,12 (aoa)
PAVEMENT			
VENTILATED SLAB | REINFORCED CONCRETE	M2	(AOA)5.385,00	360 795,00 (aoa)
FLOOR PAVEMENT | WOOD	M2	(AOA)3.523,82	
WALLS			
EXTERIOR| MASONRY BRICK	M2	(AOA)1.793,45	3 831 376,80 (aoa)
EXTERIOR | CONCRETE	M2	(AOA)13.881,80	
EXTERIOR | STEEL	M2	(AOA)2.480,20	
INTERIOR| MOSQUITOES NET SCREEN	M2	(AOA)4.600,55	
INTERIOR | WOOD SCREEN	M2	(AOA)61.837,67	
INTERIOR | STRAW SCREEN	M2	(AOA)20.902,00	
STAIRS AND BRIDGES			
STAIRS| STEEL STRUCTURE	M2	(AOA)1 232,78	9 862,24 (aoa)
BRIDGES | STEEL STRUCTURE	M2	(AOA)1 231,74	4 926,96 (aoa)
STAIRS | SLAB COVER	M2	(AOA)8.419,01	109 447,13 (aoa)
STAIRS| STANDARD CONCRETE	M2	(AOA)7.150,27	
ROOF TOPPING			
ROOF| REINFORCED STRUCTURAL SLAB	M2	(AOA)5.724,02	383 509,34 (aoa)
ROOF | PANEL CONCRETE SLAB	M2	(AOA)6.142,48	
	TOTAL		6 767 080,63 (aoa)

CONSTRUCTION ESTIMATE

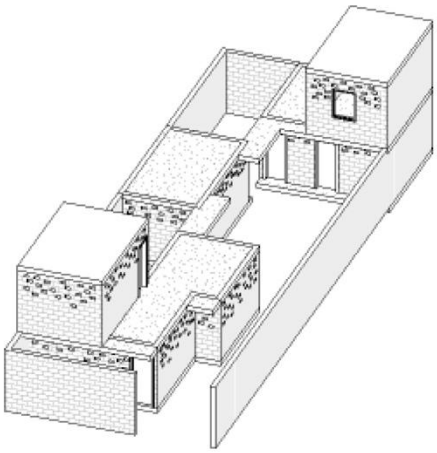
AUTODESK.

bo_regular_energia (3)

bo_regular_energia Análise

Analisado em 05/05/2018 17:52:03

Resultado da análise de energia do Revit



Fatores de desempenho do edifício

Localização:	Luanda, Angola
Estação de metereologia:	169024
Temperatura externa:	Máx: 29°C/Mínimo: 9°C
Área do piso:	80 m²
Área da parede externa:	217 m²
Potência média de iluminação:	4.84 W/m²
Pessoas:	1 pessoas
Coeficiente de janela externa:	0,04
Custo de eletricidade:	$ 0,14/kWh
Custo de combustível:	$ 0,14/Térmica

Intensidade de utilização de energia

EUI de eletricidade:	82 kWh/sm/amo
EUI de combustível:	283 MJ/sm/ano
EUI total:	579 MJ/sm/ano

Utilização/Custo do clico de vida da energia

Utilização de ciclo de vida da eletricidade:	162,658 kWh
Utilização do ciclo de vida do combustível:	558,516 MJ
Custo de ciclo de vida da energia:	$ 10.495

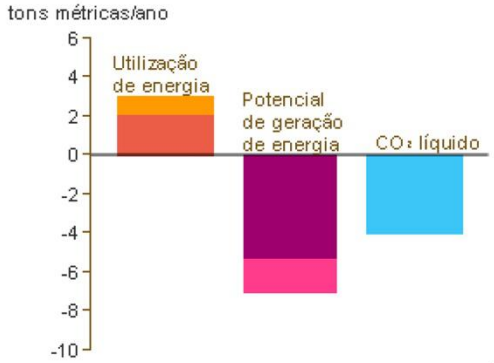
*Vida por 30 anos e 6.1% de taxa de desconto para custos

Potencial de energia renovável

Sistema PV Montado no Telhado (Baixa eficácia):	4,535 kWh/ano
Sistema PV Montado no Telhado (Média eficácia):	9,070 kWh/ano
Sistema PV Montado no Telhado (Alta eficácia):	13,604 kWh/ano
Potencial de Turbina de Vento 15' Única:	4,811 kWh/ano

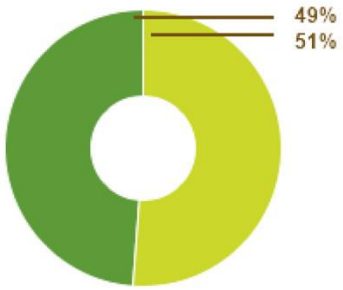
*As eficácias PV são assumidas como 5%, 10% e 15% para sistemas de baixa, média de alta eficácia

Emissões anuais de carbono



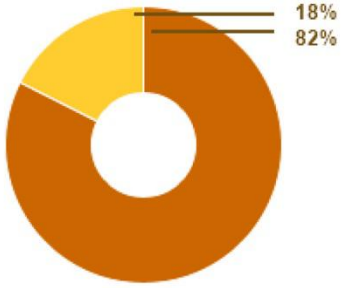
	(tons métricas/ano)
Consumo de eletricidade	2
Consumo de combustível	0
Potencial PV de Telhado (Alta Eficiência)	-5
Potencial de Turbina de Vento 15' Única	-1
CO_2 líquido	-4

Utilização/Custo anual de energia



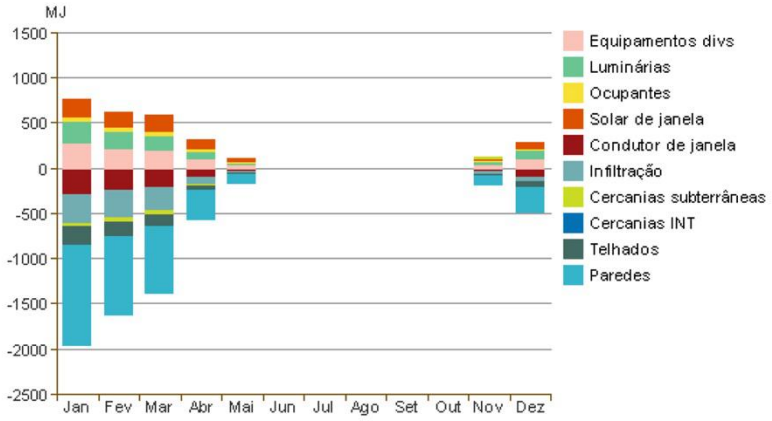
Eletricidade	51%	$745	5,421	kWh
Combustível	49%	$26	18,617	MJ
		$771		

Utilização da energia: Combustível

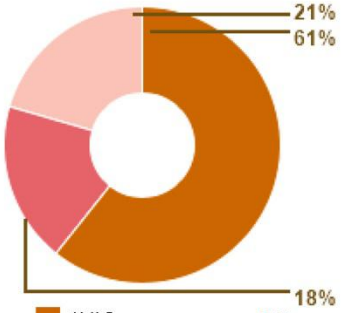


			(MJ)
AVAC	82%	$21	15,348
Água quente res.	18%	$4	3,269
		$25	18,617

Carga mensal de aquecimento

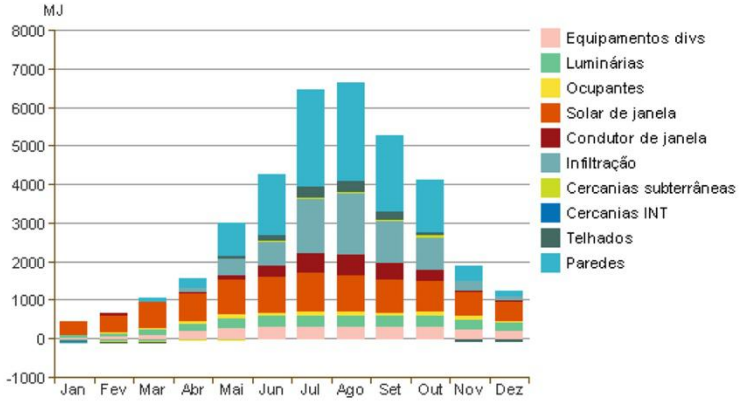


Utilização de energia: Eletricidade

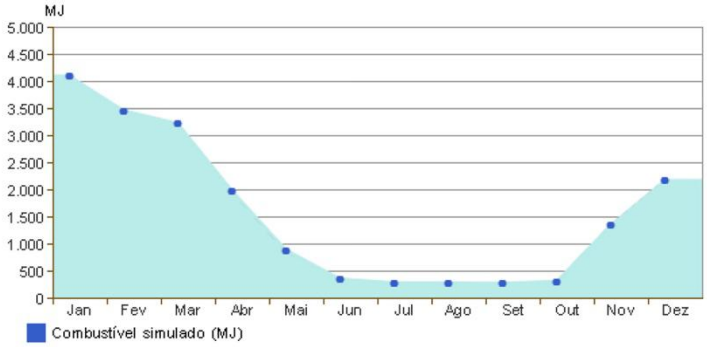


			(kWh)
AVAC	61%	$452	3,291
Iluminação	18%	$139	1,018
Equipamentos divs	21%	$152	1,112
		$743	5,421

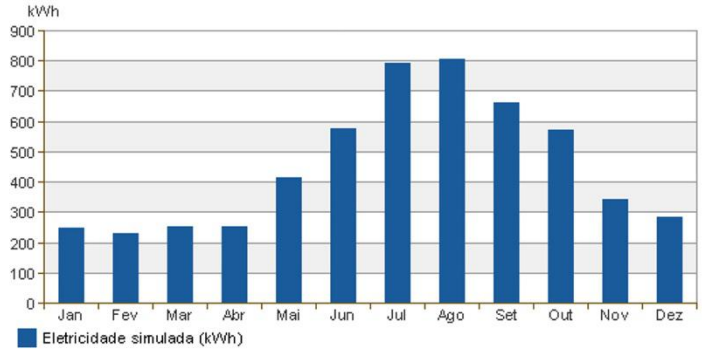
Carga mensal de refrigeração



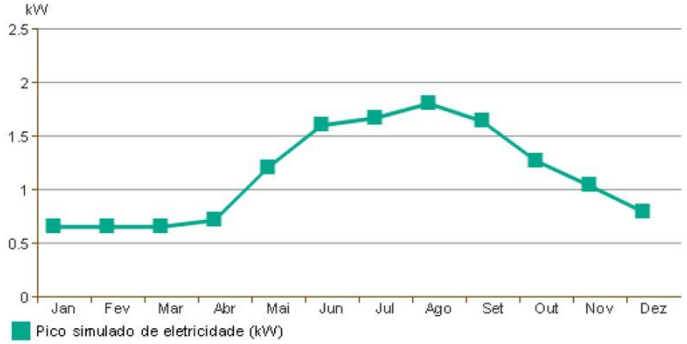
Consumo mensal de combustível



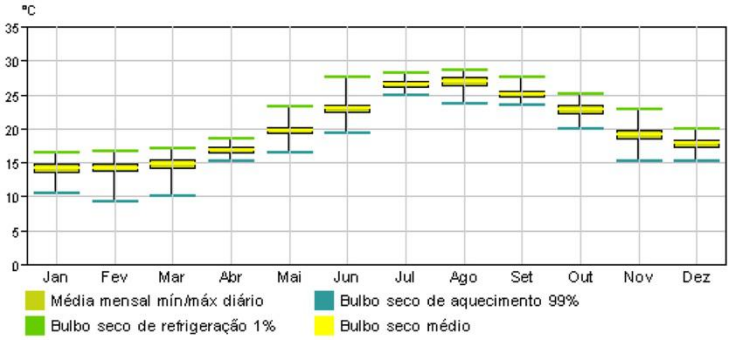
Consumo mensal de eletricidade



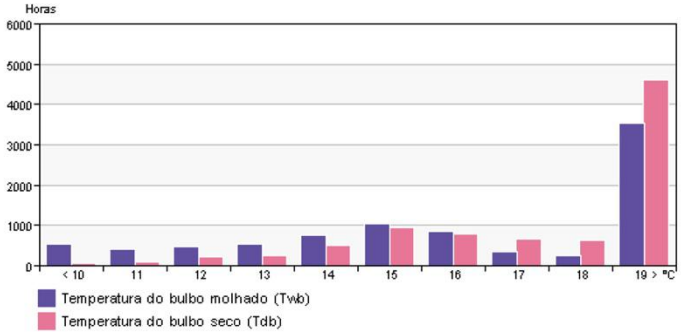
Demanda mensal no pico



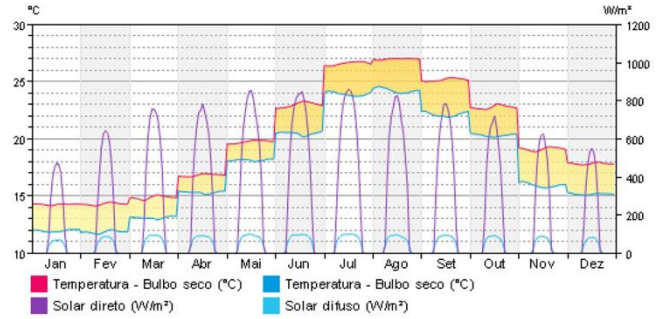
Dados mensais do projeto



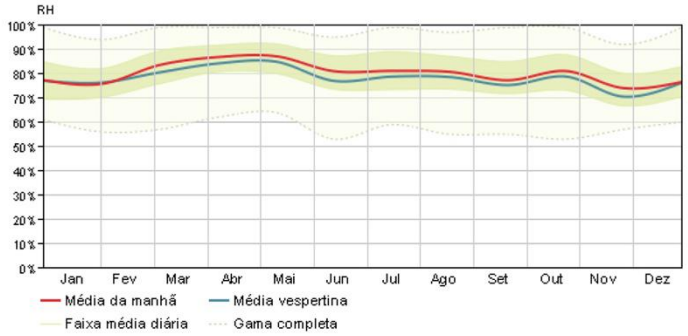
Faixa anual de temperatura



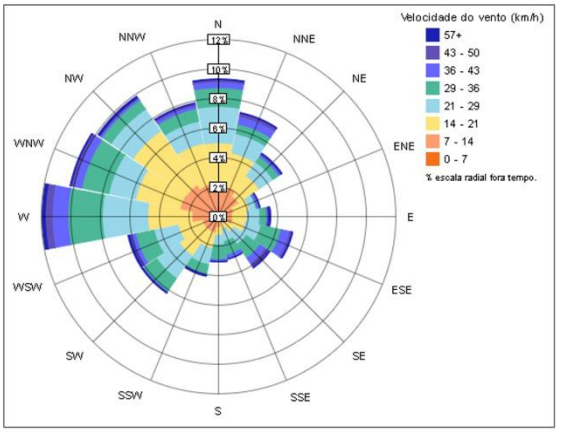
Média diurna do clima



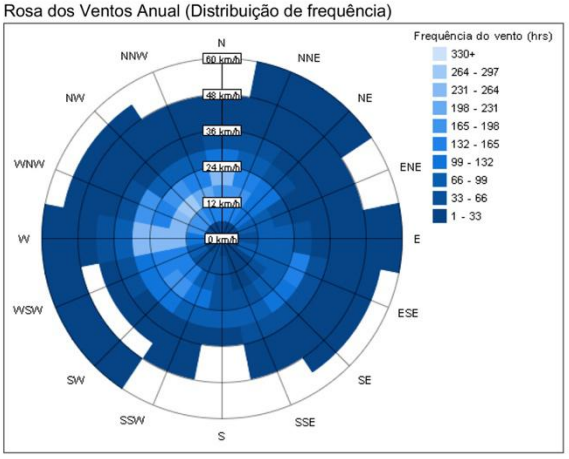
Humidade



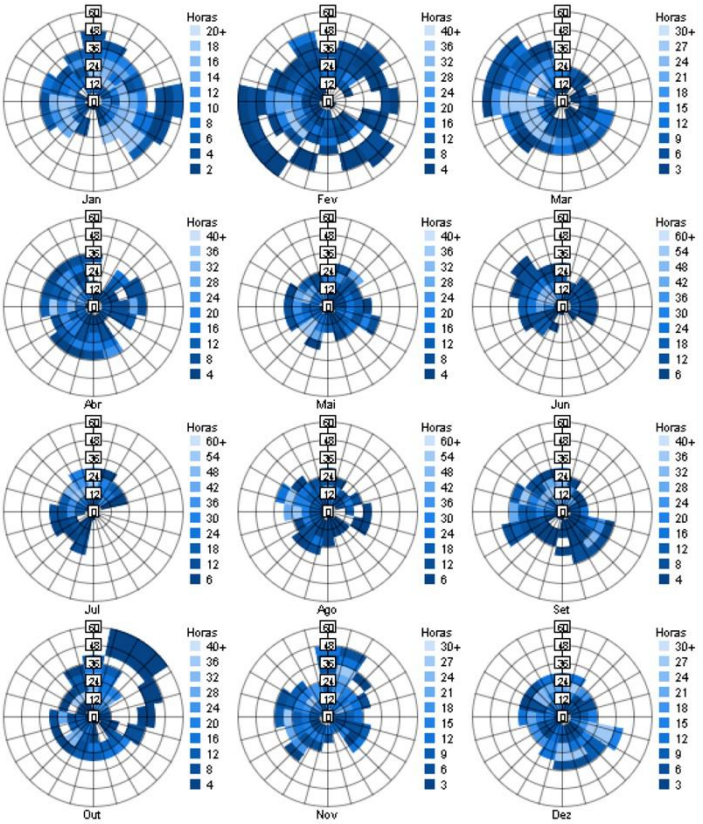
Rosa dos Ventos Anual (Distribuição de velocidade)



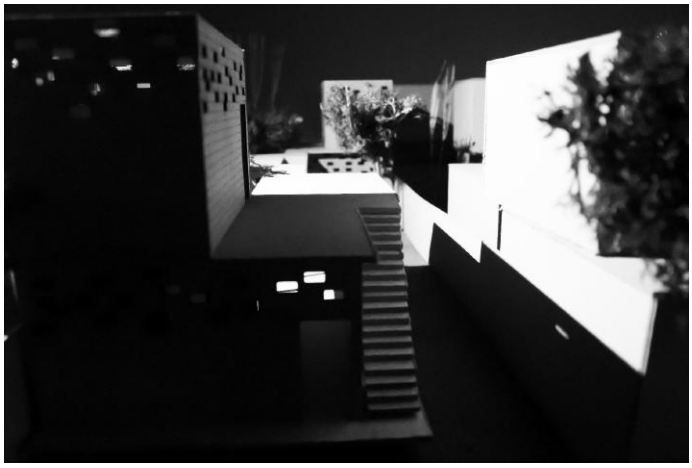
Rosa dos Ventos Anual (Distribuição de frequência)

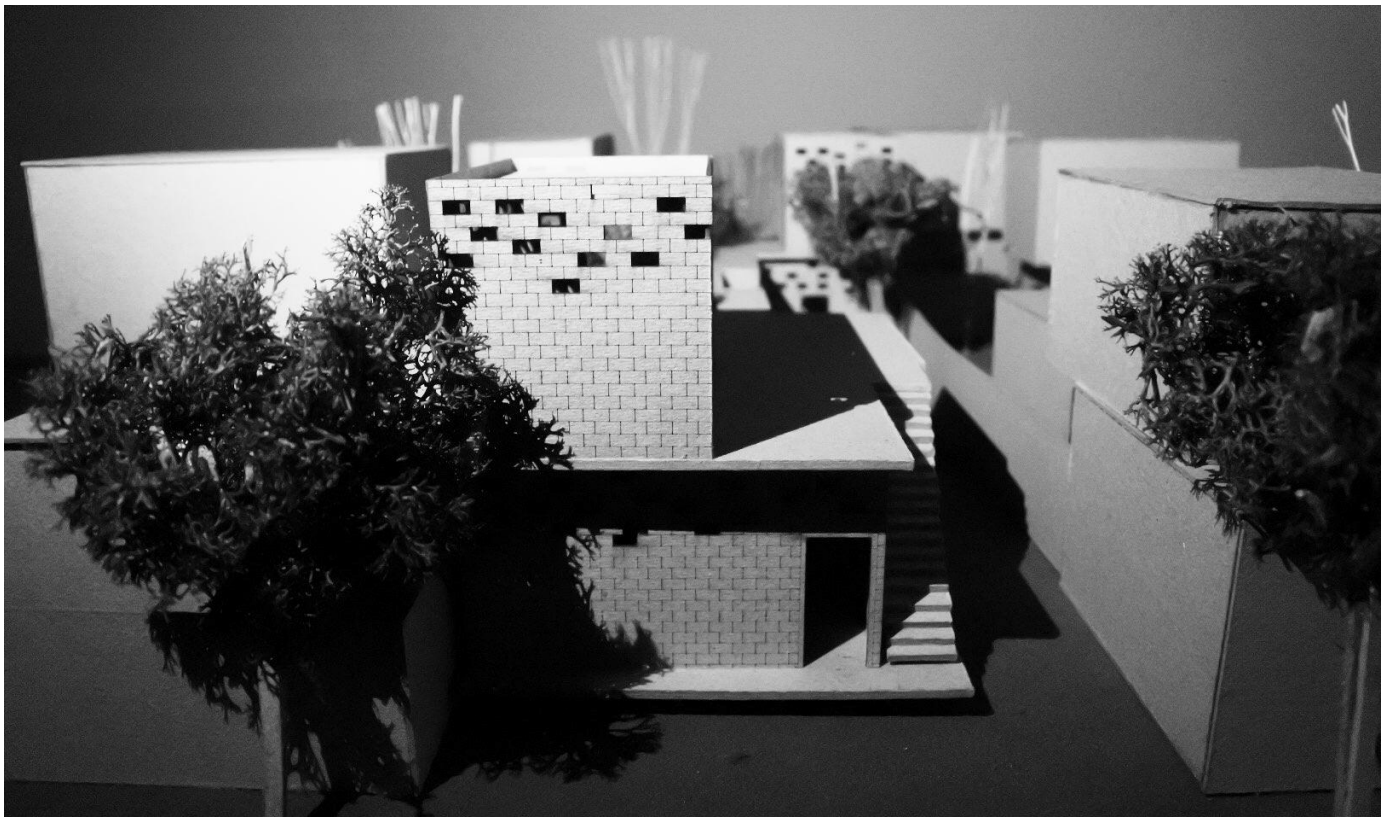


Rosas de Vento Mensais



BAIRRO OPERÁRIO | FINAL MODEL PHOTOS





MUSSUS

[INSERT : NAME MUSSEQUE]

[INSERT : LOCATION , BLOCK, HOUSE]

N

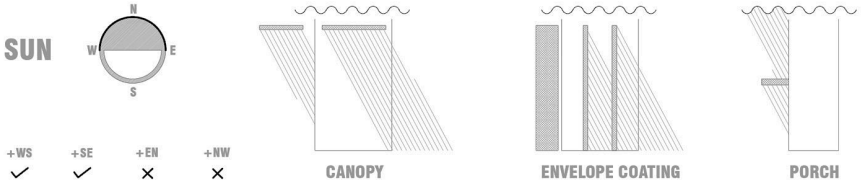
FAMILY UNIT [INSERT FAMILY NAME : SURNAME]

KINSHIP	FULL NAME	AGE	GENDER

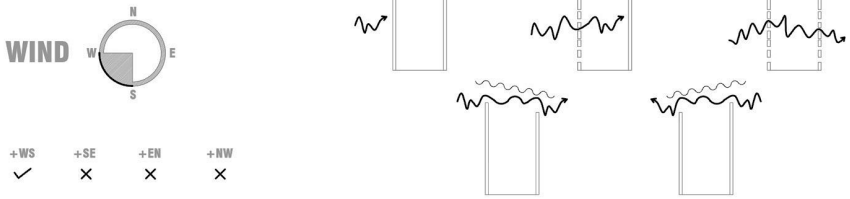
DESCRIPTIONS : [INSERT : BLOCK NAME : HOUSE NAME]
[INSERT : DETAILS]

POSITION AND ORIENTATION

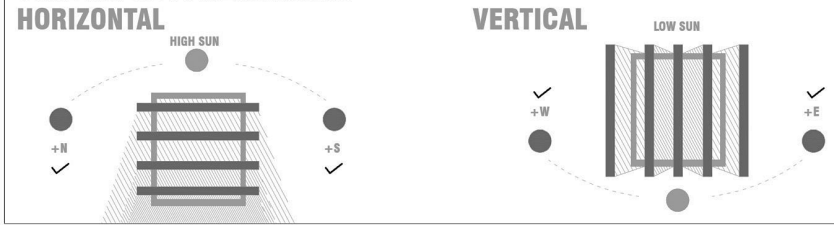
RADIATION RECOMENDATIONS



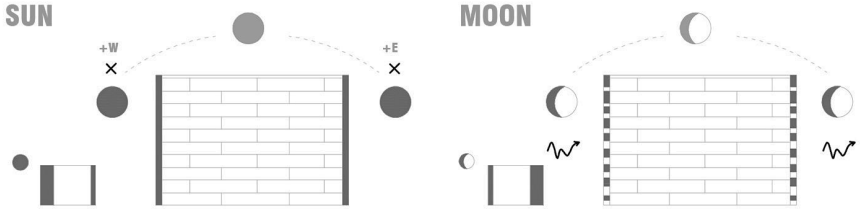
WIND RECOMENDATIONS



SHADING RECOMENDATIONS



DAY AND NIGHT RECOMENDATIONS



PASSIVE MEASURES

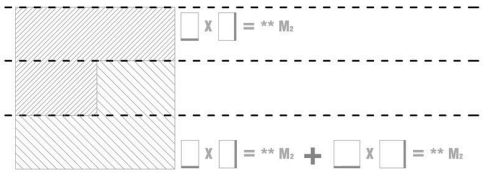
AREA BOUND

TOTAL MAXIMUM

3RD FLOOR

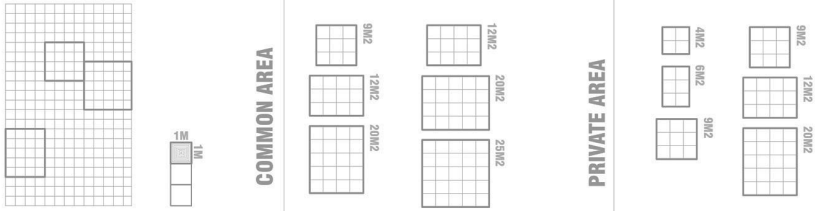
2ND FLOOR

1ST FLOOR

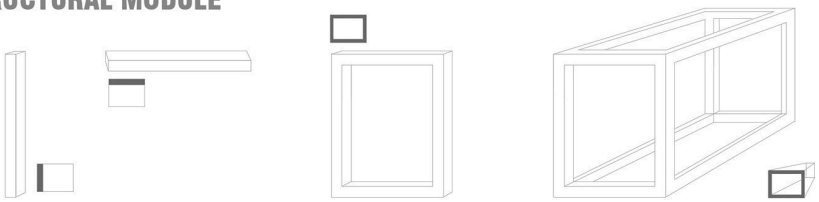


150 M2 - 200 M2

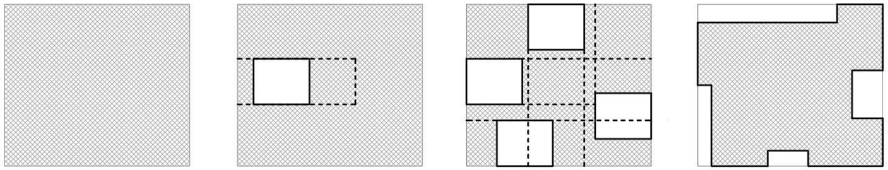
AREA DIMENSION



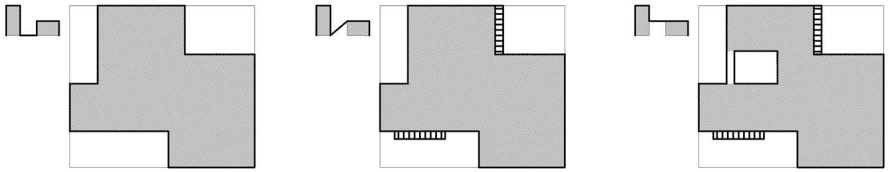
STRUCTURAL MODULE



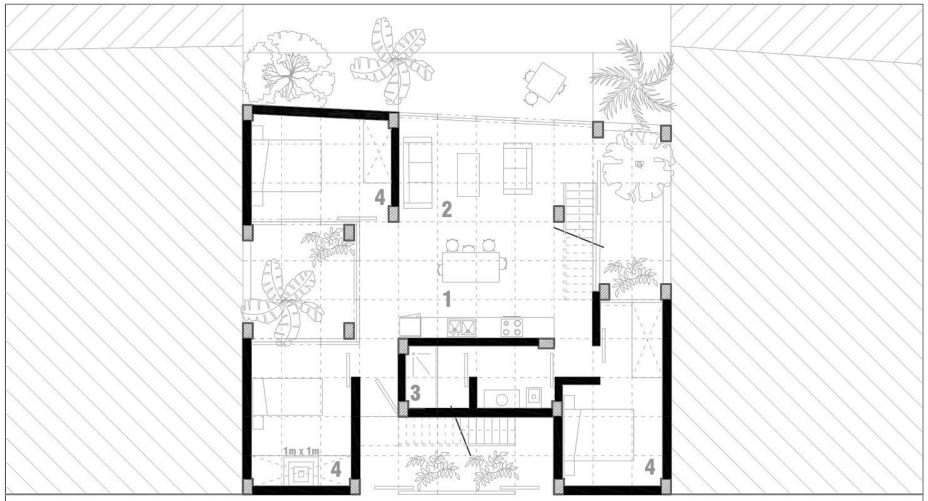
PATIUMS



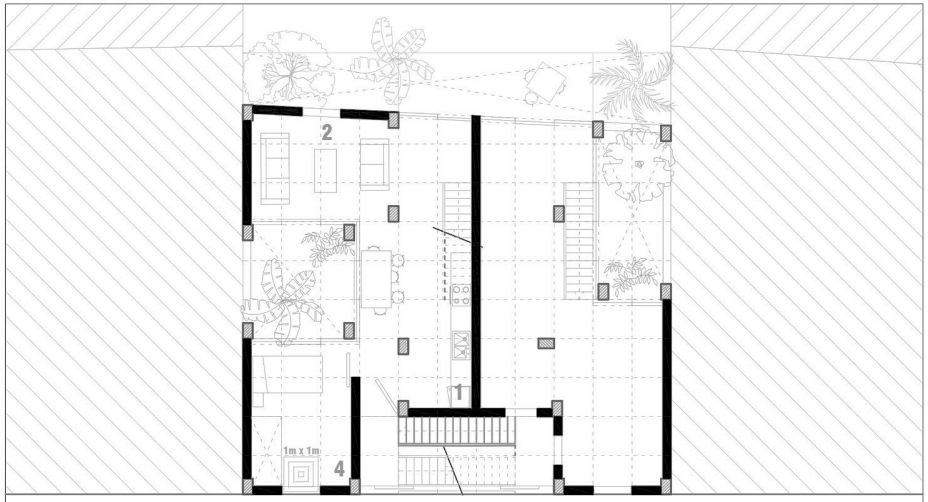
STAIRS AND BRIDGES



CONCEPT



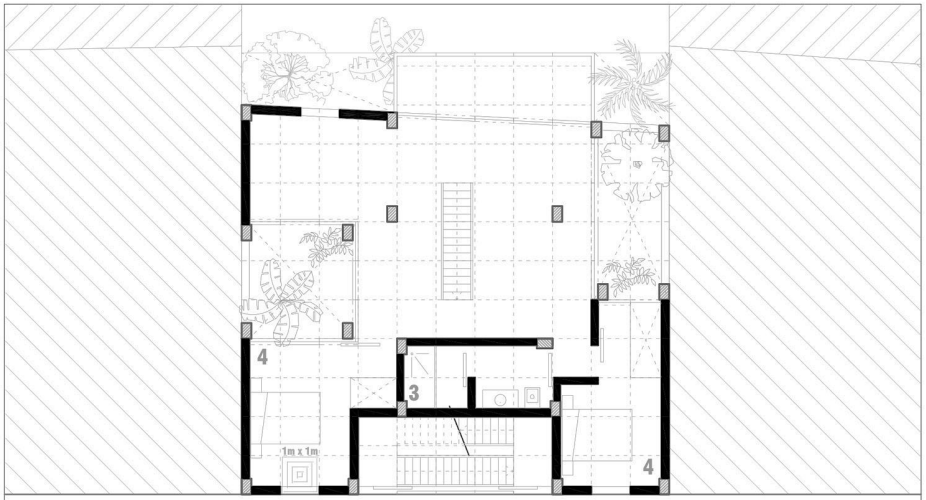
PLAN #1



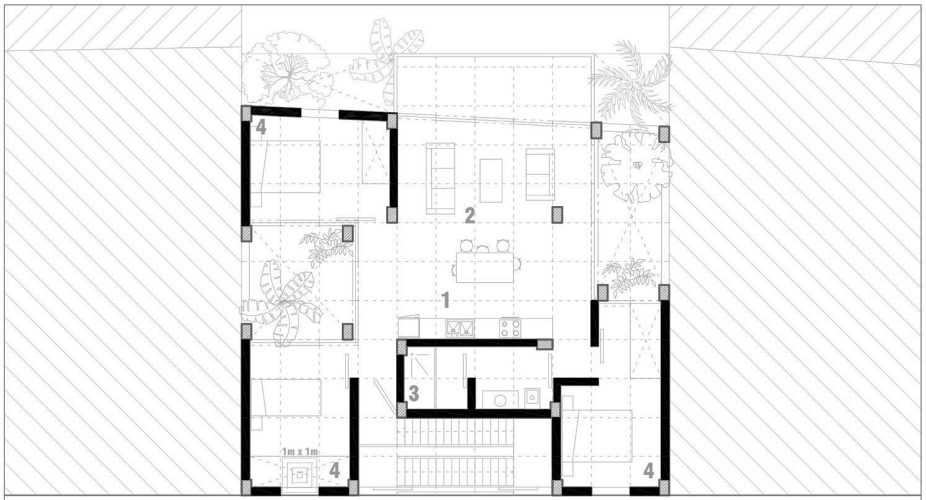
PLAN #2

DESCRIPTIONS : [1] KITCHEN
[2] LIVING ROOM
[3] BATHROOM
[4] BEDROOM
[5] TERRACE

PLANS



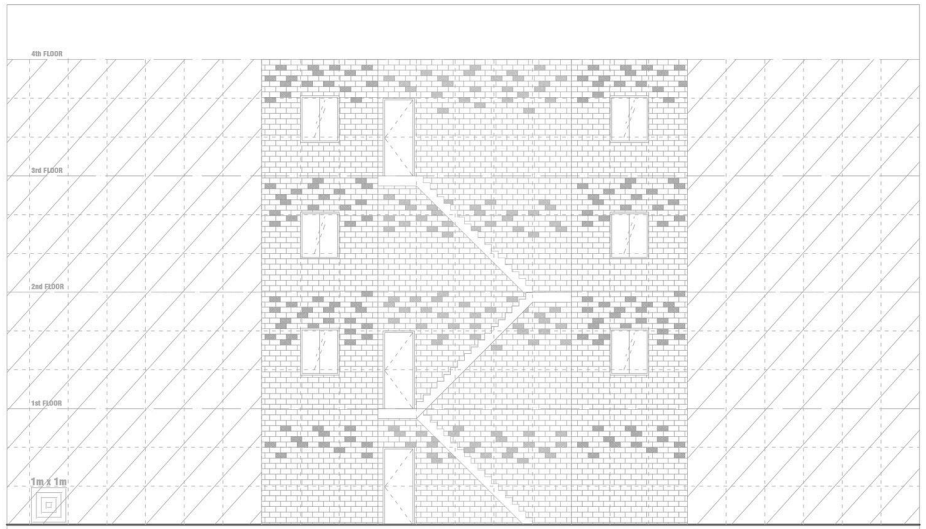
PLAN #3



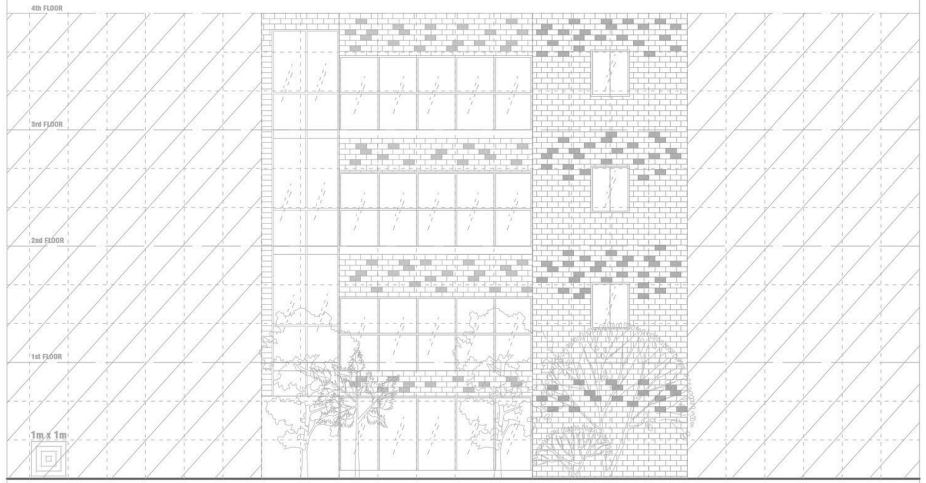
PLAN #4

DESCRIPTIONS : [1] KITCHEN
[2] LIVING ROOM
[3] BATHROOM
[4] BEDROOM
[5] TERRACE

PLANS



FRONT



BACK

DESCRIPTIONS : [INSERT : DETAILS]

ELEVATIONS

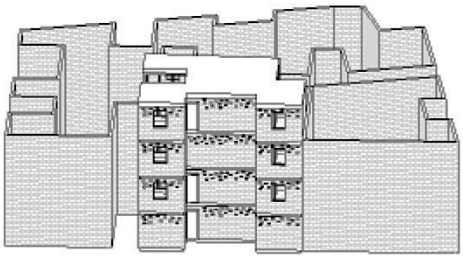
AUTODESK.

rangel_irregular_energia

rangel_irregular_energia Análise

Analisado em 05/05/2018 21:05:01

Resultado da análise de energia do Revit



Fatores de desempenho do edifício

Localização:	Luanda, Angola
Estação de metereologia:	169024
Temperatura externa:	Máx: 29°C/Mínimo: 9°C
Área do piso:	241 m²
Área da parede externa:	358 m²
Potência média de iluminação:	6.46 W/m²
Pessoas:	4 pessoas
Coeficiente de janela externa:	0,40
Custo de eletricidade:	$ 0,09/kWh
Custo de combustível:	$ 0,78/Térmica

Intensidade de utilização de energia

EUI de eletricidade:	149 kWh/sm/amo
EUI de combustível:	463 MJ/sm/ano
EUI total:	999 MJ/sm/ano

Utilização/Custo do clico de vida da energia

Utilização de ciclo de vida da eletricidade:	671,439 kWh
Utilização do ciclo de vida do combustível:	2,091,586 MJ
Custo de ciclo de vida da energia:	$ 35.677

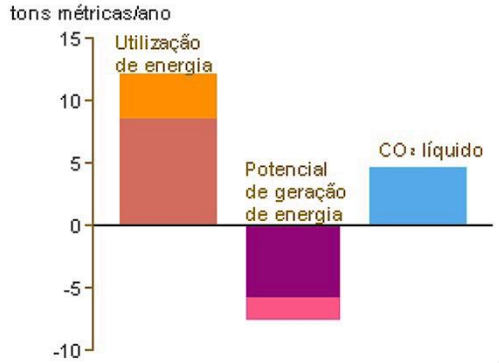
*Vida por 30 anos e 6.1% de taxa de desconto para custos

Potencial de energia renovável

Sistema PV Montado no Telhado (Baixa eficácia):	4,873 kWh/ano
Sistema PV Montado no Telhado (Média eficácia):	9,746 kWh/ano
Sistema PV Montado no Telhado (Alta eficácia):	14,619 kWh/ano
Potencial de Turbina de Vento 15' Única:	4,811 kWh/ano

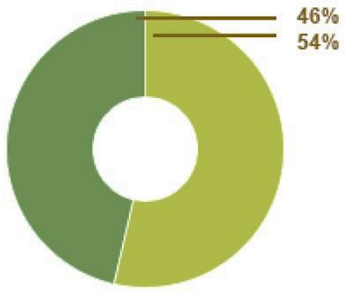
*As eficácias PV são assumidas como 5%, 10% e 15% para sistemas de baixa, média de alta eficácia

Emissões anuais de carbono



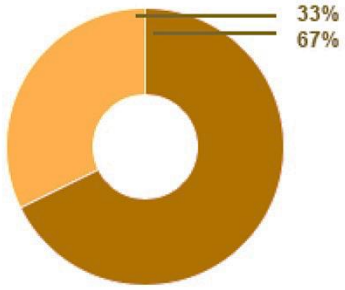
	(tons métricas/ano)
Consumo de eletricidade	8
Consumo de combustível	3
Potencial PV de Telhado (Alta Eficiência)	-5
Potencial de Turbina de Vento 15' Única	-1
CO_2 líquido	5

Utilização/Custo anual de energia



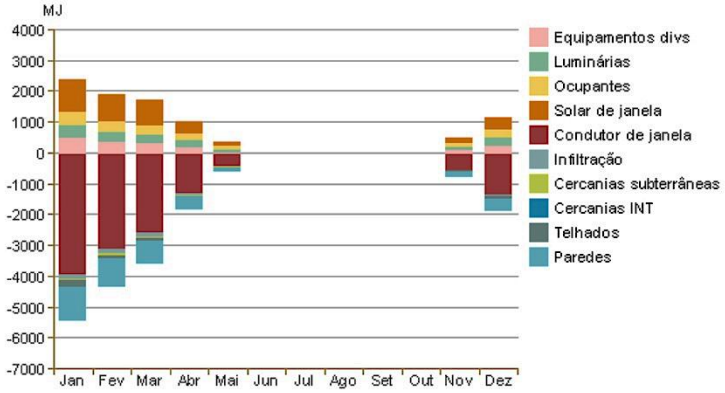
Eletricidade	54%	$2,102	22,381	kWh
Combustível	46%	$518	69,719	MJ
		$2,619		

Utilização da energia: Combustível

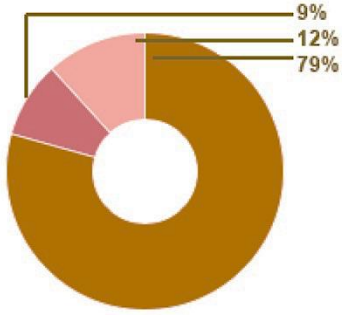


			(MJ)
AVAC	67%	$350	47,225
Água quente res.	33%	$167	22,493
		$517	69,718

Carga mensal de aquecimento

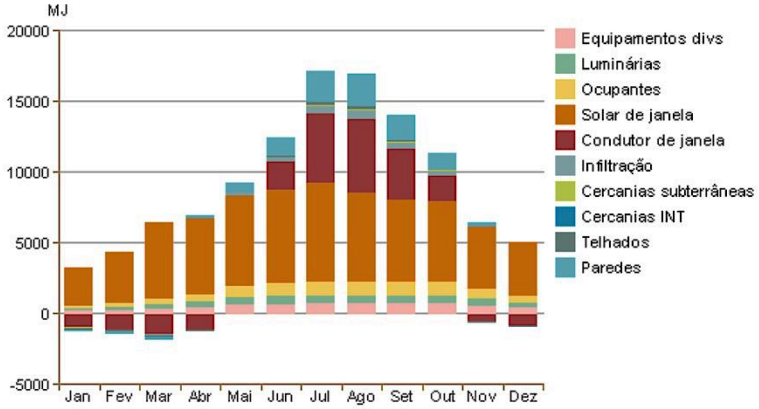


Utilização de energia: Eletricidade

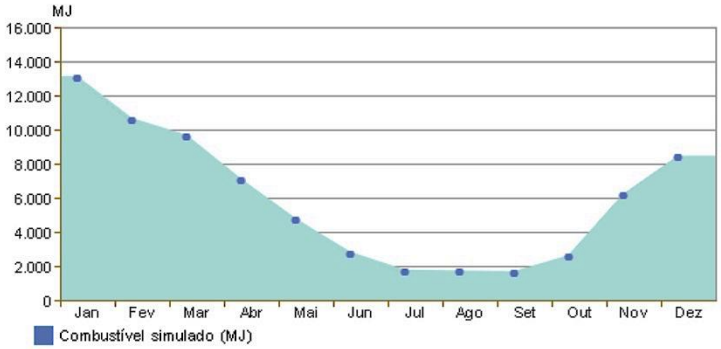


			(kWh)
AVAC	79%	$1,667	17,760
Iluminação	9%	$186	1,991
Equipamentos divs	12%	$246	2,629
		$2,099	22,380

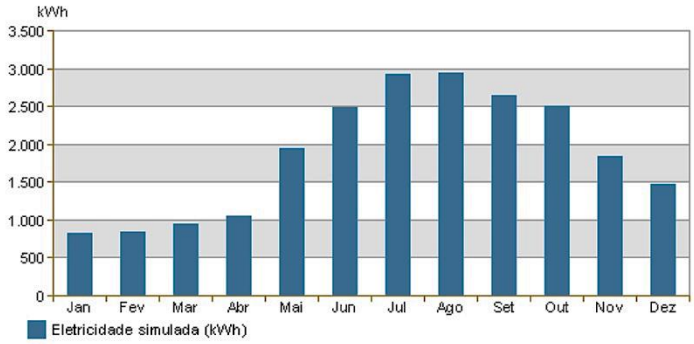
Carga mensal de refrigeração



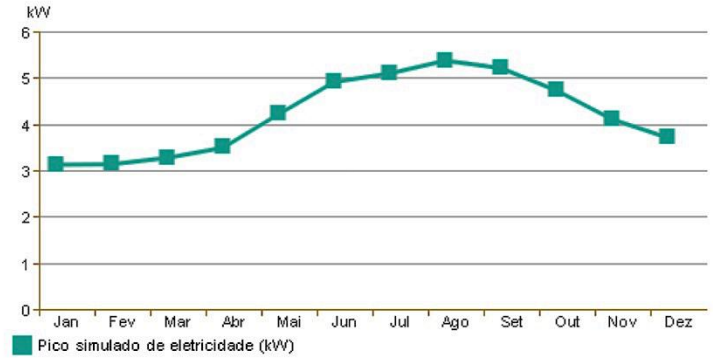
Consumo mensal de combustível



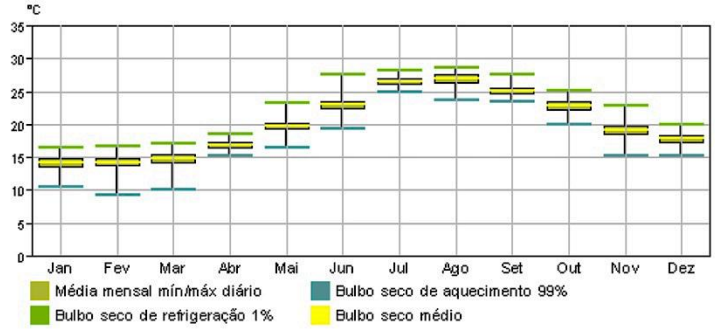
Consumo mensal de eletricidade



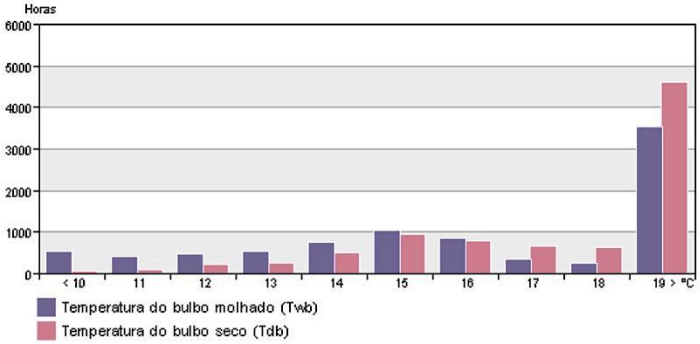
Demanda mensal no pico



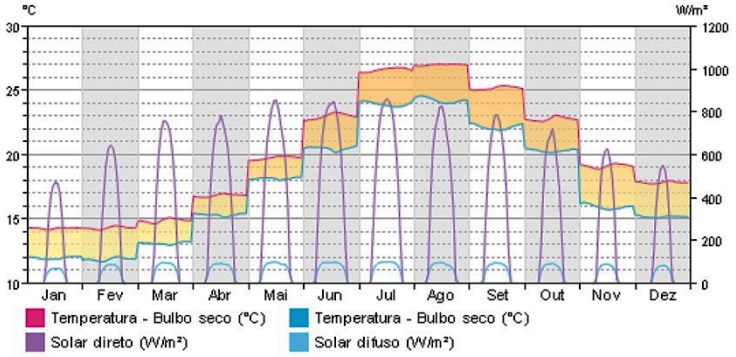
Dados mensais do projeto



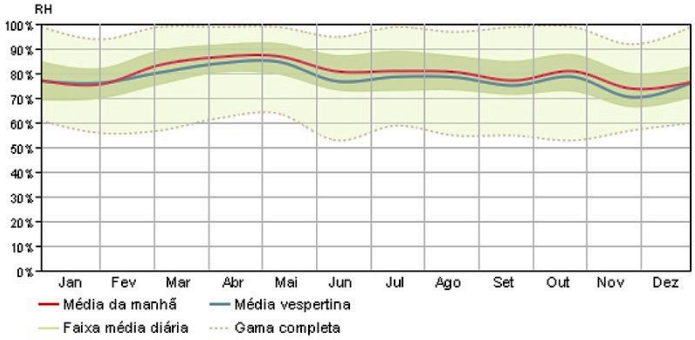
Faixa anual de temperatura



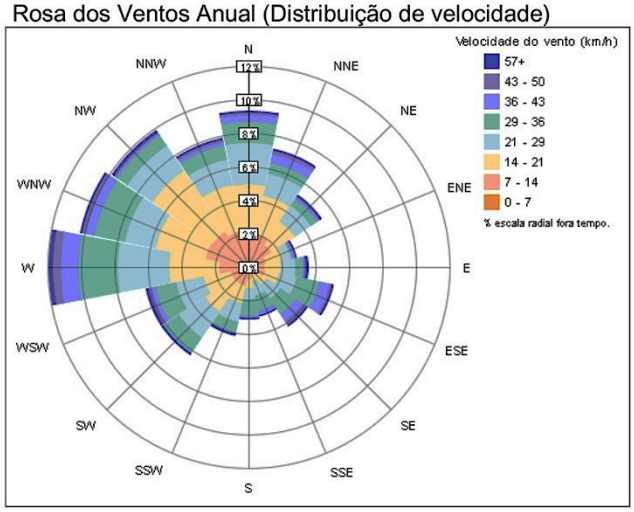
Média diurna do clima



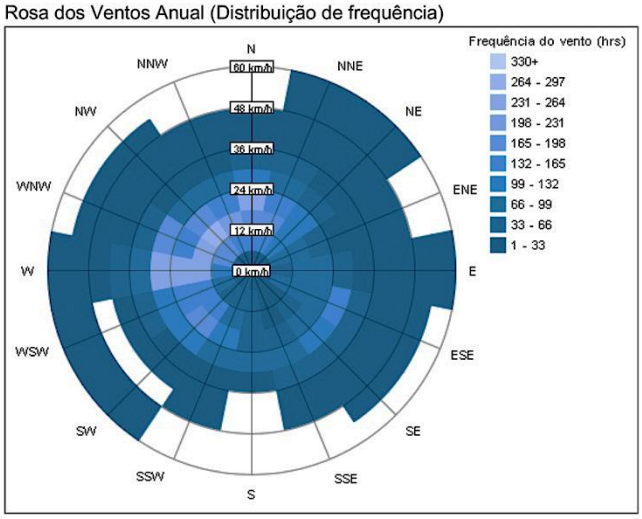
Humidade



Rosa dos Ventos Anual (Distribuição de velocidade)



Rosa dos Ventos Anual (Distribuição de frequência)



Rosas de Vento Mensais