TÉCNICO LISBOA

Sustainable Architecture in East Timor

UMA Project

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Extended Abstract of the Thesis to obtain the Master of Science Degree in

Architecture

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Introduction

Most of the population lives in rural areas and depends on agriculture. Basic infrastructure such as water and sanitation, electricity, health care, transportation and communication routes such as roads are not accessible to most of the population. In Dili, East Timor's capital, about 23% of the population is unemployed. This figure is even higher in rural areas where it reaches the value of 40% (Census 2010, ETG)

The development of East Timor is still very dependent on funds from the oil, which makes it important to stimulate other investment areas such as real estate and construction, aiming at the growth and sustainability of the country's natural and monetary economy.

Given the current housing map of the timorese population and the need for infrastructure development that can keep up with its growth, it was decided that the primary focus would be housing.

This thesis contains a compilation of existing literature on East Timor's architecture followed by an analysis of the sustainability aspects with greater focus on bioclimatic strategies.

The information collected and analyzed resulted in the design of a modular house - *UMA* Project - following good building practices that ensure not only sustainability, but also the response to current housing needs and the reduction of the need for energy consumption by applying a low thermal inertia material.

Figure 1.1: Chapter 1 | Architecture of East Timor (Pictures of Manuel Correia Guedes)

1 | Architecture of East Timor

The configuration and materialization of Timorese Architecture was influenced by several factors. This chapter is divided into three sections with information about the State of the Art, Framing and Architectural Typologies of East Timor.

The State of the Art contains the presentation of the main works studied on the Timorese Architecture: *Architecture Timorese* by Ruy Cinnati; *Atlas of East Timor* by GERTiL of the Lisbon Faculty of Architecture and *Sustainable Architecture in East Timor: Good Practice Manual*, developed under the *SURE-Africa* Project.

The Framework geographically locates the island of Timor and features the different administrative divisions - districts, subdistricts and villages (sucus); the description of the country's demographics according to the Preliminary Results of the National Census of Population and Housing of East Timor 2015 (Census 2015, ETG); the brief summary of the country's history; the presentation of the topography and climate; the presentation of the conditioning factors of human occupation; the description of the different forms of population in urban and rural areas and the description of the timorese family.

The third and final section of this chapter features the architectural typologies present in the East Timorese territory: Traditional Architecture - materials , construction technologies, typological framework of settlement and traditional housing map according to Ruy Cinnati; Colonial Portuguese Architecture; Indonesian Occupation Architecture and Contemporary Architecture - materials, selfconstrution and Ecotourism .

Figure 2.1: Chapter 2 | Princípios da Arquitetura Sustentável (Pictures of Manuel Correia Guedes)

2 | Principles of Sustainable Architecture

The term *Sustainability* is usually associated with the *Sustainable Development* which is defined by the World Commission on Environment and Development as:

> "*Development that meets the needs of the present without compromising the development of future generations.*"

In the context of Sustainable Architecture arises the concept of bioclimatic architecture, which consists in the design of buildings taking into account the characteristics of the environment in which they are placed, in order to minimize environmental impact and energy consumption.

Sustainability faces legal, economical, social and political challenges that are not always compatible. Sustainable growth can only be achieved when government organizations take environmental development as a competitive advantage by reducing the impacts and construction costs.

The implementation of passive design strategies allows a comfortable environment within buildings, even with reduced power consumption, easing the adaptation of buildings to the surroundings through the use of materials and techniques that reduce the need to use mechanical systems powered by non-renewable energy (Guedes et al., 2015). This reality makes it imperative to integrate these strategies in new construction projects so that sustainability can achieved.

This chapter contains strategies based on Sustainable Architecture Principles appropriate to the East Timor's territory with regards to: Location, Shape and Orientation; Isolation; Shadowing; Passive Cooling Systems; Thermal Inertia; Control of Internal Gains; Comfort Criteria; Active Cooling Systems; Energy; Water, Sanitation and Drainage; Urban Sustainability and Sustainability Principles in Timorese Architecture.

Figure 3.1: Chapter 3 | Case Studies (Adapted from *ArchDaily* Brasil e *Mima Housing*)

3 | Case Studies

This chapter features three case studies relevant to the *UMA* Project:

> ***Minimod House* — MAPA *Architects***
>
> *Minimod House* strives for nature contact, bringing a new reading of the boundary between natural and artificial. Its basic configuration can be increased by adding modules 100% pre-manufactured with recycled wood.
>
> **MIMA *House* — MIMA Lab**
>
> MIMA *House* is a simple and flexible modular house that has a unique beauty and architectural quality. Its concept was developed to allow the rapid manufacture and assembly of the structure.
>
> ***Drop House* — D3 *Architectes***
>
> *Drop House* develops along a shaft in which are located the housing main divisions. Its design minimizes waste and energy consumption allowing the use of renewable energy sources.

After the analysis of the three case studies, we came to the conclusion that the *UMA* Project should be a modular structure with the possibility of increasing its size and have a versatile interior space configuration.

Rapid construction and manufacturing are also important factors in this project. To this end the main materials chosen for its construction will be preferably local and easy to handle. The implementation of bioclimatic strategies appears as an asset in the project not only in environmental but mainly in social terms, resulting in a population quality of life increase.

Figure 4.1: Chapter 4 | *UMA* Project

4 | *UMA* Project

The housing construction is one of the areas with the greatest impact on the daily life of timorese population and also the one that needs the most investment. When it comes to the design of house to implement in East Timor it is important that it is easily adaptable to the reality of each family and the specificity of each site.

The *UMA* Project is a modular house with a scalable and adaptable configuration. It seeks not only to respond to the housing program, but reconcile the cultural and traditional roots in order to contribute to the development of East Timor.

The premises of this project are the design of a passive house that integrates strategies for sustainability and the possibility of expansion and adaptation to reality and evolution of each family.

The default size of the modular house structure has a dimension of 2.5 x 2.5m composed of 18 modules - 6 units long by 3 wide - flanked by two balconies with 1.25m depth: one in the front and the other in the back facade.

In the reticulated mesh lying on the support base of the whole structure are predefined plugins that are intended for space dividing panels. This structure allows the inner space to be manipulated in increments of 2.5m according to the needs of each customer.

This chapter contains the presentation of the *UMA* Project followed by a comparative analysis of energy performance when materialized in two different ways - masonry and wood. The results show that wood is the material with better thermal behavior against the Ermera clime.

5 | Project Recomendations

This study identifies two aspects of great significance for the energy performance of the *UMA* Project which is dependent on its material - wood or masonry - as well as the comfort criteria on the location on which it will be deployed.

It was found as the most significant result of the analysis, that the wood has potential advantages over the masonry. Note that the choice of interior comfort temperature for Ermera also had a major impact on the energy performance results.

Following the previous chapters, based on the literature and the positive results presented was drawn up a list of some general recommendations for sustainable construction in East Timor.

Conclusion

Sustainability in architecture is a theme that is highlighted not only by the profound impact it has on the quality of life of society, but the fact that the natural resources of planet Earth are exhaustible. This reality means that there is a need to preserve them through sustainability strategies and thus prevent human consumption pressure to lead them to extinction.

East Timor has abundant oil, but the investment in building the future of the country also includes the architecture. In this thesis were presented measures to sustainability in timorese architecture that will enable the rational and efficient use of natural resources of the country applied in the construction industry.

The location and configuration of the housing clusters should be made to protect the homes from dangerous situations like floods in rainy areas and overheating in areas with many hours of direct sunlight.

The thermal insulation of the most exposed opaque areas to solar radiation (such as the covers) plays an important role in the proper functioning of the building and the comfort experienced by users. This isolation can be achieved through the use of native plant materials. The glazed areas should have special attention when it comes to choosing the type of glass and guidance to prevent space overheating.

Strategies such as shading and natural ventilation are key in reducing cooling loads, often achieved by devices which consume non-renewable energy.

The isolation of solar radiation incidence on the constructions can be achieved through the use of vegetation near buildings. The position and size of the vegetation must be made according to the need for natural ventilation and lighting since it can either potentiate or attenuate them.

The implementation of renewable energy systems is a good measure to safeguard the environment, not only because it enables the production of energy without causing pollution but also beacuse these can be built with recycled materials.

The material used in the construction has a big impact on energy consumption since it can increase or decrease the thermal inertia. It was found in the analysis in Chapter 4 that in East Timor the wooden

buildings have better results in the thermal performance than the masonry ones by having lower cooling loads.

This work could be complemented with the study of the effectiveness of the implementation of active and complementary measures in the *UMA* Project and the feedback time of its application.

Note that the energy performance of the building depends not only on their physical and spatial characteristics, but also other factors such as: the type of existing infrastructure, the equipment used and the behavior of its users.

The success of the construction depends on several agents - architects, engineers, owners, and users - to implement sustainable strategies throughout the city, also improving the quality of life of the population.

In the future it would be pertinent to conduct further analysis of the issue in question, for example through on-site measurements and conducting questionnaires to know the expectations of users on questions related to the use of wood and masonry.

It would also be relevant the specialization on the use of wood in construction with more detailed analysis in terms of thermal performance, energy and costs, expanding knowledge about advantages and disadvantages of using each material, aiming at informing the *UMA* Project.

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