



# **SUSTAINABLE REHABILITATION OF TOURISM COMPLEXES**

Case study analysis - Casa Modesta, Olhão

**Sara da Silva Mendes**

## **Extended Abstract**

Thesis to obtain the Master of Science Degree in  
**Architecture**

Supervisor: Prof. Doutor Manuel Guilherme Caras Altas Duarte Pinheiro

**Juri**

Chairperson: Prof.<sup>a</sup> Doutora Helena Silva Barranha Gomes

Supervisor: Prof. Doutor Manuel Guilherme Caras Altas Duarte Pinheiro

Member of the Committee: Prof. Doutor Manuel de Arriaga Brito Correia

**December 2014**

# SUSTAINABLE REHABILITATION OF TOURISM COMPLEXES

Case study analysis - Casa Modesta, Olhão

Sara da Silva Mendes | Instituto Superior Técnico, UTL | December 2014

**ABSTRACT** | Tourism is a strategic macroeconomic sector for Portugal. One of its strategic approaches is the development of new tourist projects. However, due to the current economic environment among other motives, the rehabilitation of buildings and requalification of touristic areas is both an opportunity and a challenge for promoters and public agents.

Architecture has a key role on the spaces that society inhabits. Thus, for a sustainable development, all agents have to turn traditional construction into sustainable construction and rehabilitation while being able to respond to today's comfort and well-being needs, through passive design and the use of active systems, with aims to reduce the environmental impact of the consumption of resources and to reduce costs in the operational phase of the construction.

The aim of this thesis is, through an analysis using the sustainability assessment system LiderA, to evaluate the case study of a country house tourism complex - Casa Modesta, and to map rehabilitation solutions and find improvement suggestions regarding the closure of the resources cycles and socioeconomical experiences.

The good practices in architectural design, which comply with the setting and its vernacular architecture are identified, and the project's active and passive systems are described. Afterwards rehabilitation improvement opportunities are systemized, striving/attempting to increase the environmental, social and economic performances.

In the analysis of the reduction of consumption and economic feasibility the closure of the water cycle is achieved. The overall rating of the project and after the implementation of improvements is A +.

**Keywords** | Sustainable Rehabilitation; LiderA sustainable assessment system; Tourist complexes; Improvement opportunities

## 0. INTRODUCTION

For millennia, man has adapted to the environment and knew how to find a process of rational exploitation of resources, allowing its cyclical renewal. However, civilization was not satisfied with this balanced system and broke the natural continuity of its development. (Mourão e Pedro, 2012).

With the World Summit on Sustainable Development, in Johannesburg in 2002, it was concluded that sustainable development should be based on economic, social and environmental dimensions.

The construction sector is fundamental to sustainable development in its three dimensions. Shown to be essential for improving the quality of human life and the key to the economic development of the communities, since currently people spend on average 80% to 90% of their time inside buildings. (Tirone and Nunes, 2007). Approximately 30% of new and remodeled buildings have poor indoor air quality caused by harmful emissions, humidity and poor ventilation that generate the appearance of pathogens (Augenbroe and Pearce, 1998). Hence lays the great importance of having a good design and construction of buildings so as not to endanger the health of its occupants (Pinheiro, 2006).

During the 90s, the architects raised awareness for use of excessive energy air conditioning and artificial light, and started to adapt the techniques used in the past to its passive design strategies: natural ventilation, solar orientation, thermal mass, shadows, among others (Guedes et al., 2009).

If climatic conditions were taken advantage of in Portugal, it would be possible to increase user comfort and reduce operating and maintenance costs. It should also be noted that Portugal's location is quite favorable to decentralized energy production through solar radiation, winds and rains (Tirone, 2009).

The architecture has been for centuries, due to the limitations on the field, humble in relation to nature, leading to a vernacular architecture that today increasingly resembles a sustainable architecture and therefore a good example to follow. (Cabral, 2009).

Future trends indicate that organizations are increasingly 'eco-efficient', and are starting to reconcile financial performance and competitiveness with quality and environmental and social responsibility (Lopes and Capricho, 2007). This implies the use of various instruments, such as environmental management systems; analysis of the life cycle of the product and / or service; eco-design; environmental reports; environmental labeling; production processes in a closed loop; extensive audits to suppliers, etc. (Willums, 2003).

The hotel industry and tourism ventures, due to the nature of its function, have substantial environmental impacts, consuming substantial amounts of energy, water, materials and resources, but have sought to increasingly consider and protect the natural environment in which it operates, through the creation, rehabilitation and responsible management of a healthy built environment based on resource efficiency and ecological principles contributing to the social and economic balance (LiderA, 2013).

## 1. OBJECTIVES AND METHODOLOGY

This dissertation is based on the hypothesis that the rehabilitation of touristic complexes in a sustainable manner begins in the architecture project. The objective of this work is through the analysis of a case study, determine the solutions that contribute to rehabilitation and closure of consumption cycles which are good practices that can be implemented in order to improve the environmental, social and economic performance.

As a case study, it was chosen the rehabilitation of a tourism complex, a country house - Casa Modesta - for 18 guests, situated in Algarve, in the municipality of Olhão, in the parish of Moncarapacho.

In summary, the study combines architecture design solutions that improve the quality of the building, in terms of both comfort and well-being of the customers, as well as increasing environmental efficiency, reducing resource consumption and associated costs. It is intended, by the cost factor in the life cycle, to assess improvement and achieve sustainable development.

For this purpose, the state of the art was reviewed, the project data was obtained from the LiderA's (Sustainable Assessment System) assessor that accompanies the work and a first assessment was made to learn the current status of the project with respect to the parameters evaluated at LiderA, analyzing potential opportunities to improve sustainability.

A site visit was conducted where it could gathered more information to clarify some issues and survey the state of the project, cataloged by photographic record (Mendes, 2014).

It was also carried out a new revision of the evaluation, with the most updated information, to be closed in the context of this dissertation. Criteria were consolidated, which will be validated after the closing of the project and the criteria which to date have no evidence has been identified.

A description of best practices that value environmental sustainability of the project was made, and was sought to, according to the LiderA's methodology, develop the criteria with lower ratings compared to the norm and greater weight in the evaluation and the opportunities for improving contribution on the closing of the consumption cycles.

Finally, the economic feasibility of implementing improvement opportunities that can be quantified in the reduction of the consumption of resources was studied and the results were discussed.

## 2. CASE STUDY - CHARACTERIZATION AND EVALUATION

The intervention project undertaken for the rehabilitation of a single family residential building remaining in the first half of the twentieth century,

located in the subregion of Low Algarve is described. The rehabilitation will transform the building into a tourism complex of a country house, endowing it with the valences necessary to accommodate a large number of users.

The place where it is built, well as the type of use, had great influence in the choice of materials and architecture, as well as the adoption of sustainability measures. The intervention was an opportunity to restore and add many details of the traditional architecture of the region.

It lies on the eastern Algarve, where the coast is separated from the sea by a group of sandy islands. It belongs to the Algarve limestone area and it is to note a certain nobility in its trait, and in the density of the trees typical to the subregion.

This tourism complex is a service building, is set in a rural area, has a privileged location in the protected area of Ria Formosa Natural Park.

The Casa Modesta is divided into two buildings, the house I and the house II. The houses define between them a central courtyard, which by their preexisting deployment imposes overall their great organizing lines, determining the social spaces and more intimate areas (Figure 1). This space assures the whole set an exceptional character, in that it departs from an urban dimension to approximate the scale of a country courtyard.



Figure 1 - Proposed photography- General view, West frontage (Source: PAr, 2014)

The House I refers to the retrieval / modification of the original house, where it keeps the exterior volumes of two floors. The modification of existing annexes are proposed in the House II, has approximately the same area of the existing floor with a ceiling height of 2.40m, but with a careful design, respect for the environment and respect the House I. Both houses have access to the outside through the courtyards and stairs for access to roof terraces (Figure 2).

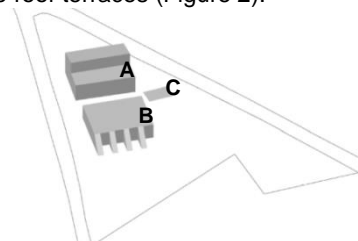


Figure 2 - Implantation diagram  
A - House I; B - House II; C - Tank

The project consists of nine Housing Units (HU). Each housing unit consists of a bedroom with storage

and sanitary installations have a built-in closet and lounge area - called "namoradeira". The housing units are facing south and have a patio access to the outer area. House I opens directly onto a shared terrace that allows access to the outer central staircase. In house II each housing unit has a patio and direct access to the garden and also has a private terrace accessible by the outside stairs.

#### ***Evaluation of environmental performance - LiderA***

It was applied version 2.0 LiderA, in which are preset 6 strands with 22 areas, which corresponds to the evaluation of 43 criteria.

It was concluded from the overall result of environmental performance evaluation, performed with LiderA 2:00 at Casa Modesta, that it is part of a certifiable class A +, which in environmental terms means, in relation to the common practice, an improvement in the environmental performance of 75.00% compared to reference E class.

### **3. SOLUTIONS FOR IMPROVING PERFORMANCE IN THE PROJECT**

#### ***Solution analysis in an integrative approach***

After studying the most influential criteria in the evaluation of the tourist complex Casa Modesta the proposals to be implemented under the scope of the performance improvement process were reduced to the criteria "analysis" and measures that do not involve structural changes.

The analysis is developed on the closing of cycles, because the effects are consecutive and aggregate form cover the three dimensions - environmental, economic and social - that are the basis for sustainable development. As this is a tourist complex, the rate of use of water, energy and materials is significant. The identified solutions allow to reduce the consumption of land, energy, water and materials; reducing the production of wastewater, air emissions and waste; and integrate socio-economic experiences and its use. The diverse improvements in sustainability studied if applied to the project would allow to benefit from a phase of operation with superior efficiency, thus contributing to better information and awareness among tourists.

The identified solutions seek to rehabilitate according to constructive systems, the vernacular architecture of Algarve, local materials and the identity of the enterprise. It should be given preference to the architectural design, through spatial enhancement, comfort, natural resources, ecosystems and flexibilization of spaces. Likewise the benefits of the implementation of passive and active systems in terms of cost, payback period and life cycle cost factor are analyzed.

During the analysis of solutions there will be distinguished the most relevant analyzes and gives the criteria a brief consideration regarding the measures. Is identified Possible Best Practice (BP) when the implementation of the solution is in the project plan, and so the innovations or solutions with a high increment of improvement are identified. There is also identification of Possible Opportunities for Improvement (OI) when a solution is proposed to be discussed as to their added value to the project.

There will also be distinguished sustainable design solutions with superior ratings to the practice in at least 37.50% (B, A, A + and A ++).

#### ***From the soil to the landscape***

##### **Analysis 01 | Territorial enhancement**

###### **• BP - rehabilitation of the building and enriching the soil**

The rehabilitation has enabled the transformation of the housing building into a tourism complex, minimizing the impacts resulting from new construction, regaining pre-existing construction from the 40s and contributing to the preservation of vernacular architecture.

The soil enrichment was performed by removing pavement which was previously waterproof and placement of fertile soil

##### **Analysis 02 | Environmental optimization**

###### **• BP - application of semipermeable pavement**

In the projects it is used grass pavers and decks with approximately 40% of permeability.

At the closing of the cycle of soil to landscape the project achieves good levels of performance, because the area where the soil is being intervened is a natural park area and because of being a rehabilitation intervention. In the area of ecosystems the impervious areas were reduced and the soil enriched, focusing on native vegetation, a vegetable garden, organic food production, herbs and fruit trees area.

The premises to rehabilitate the Casa Modesta according to the vernacular architecture of the Algarve were followed which ensure adequate landscaping (C5) distinguishing itself with class A ++. However, the criterion C6 "Protection and promotion of cultural heritage" has an evaluation class D because it only rehabilitates 25% of the area required to intervene because it was only kept the tank, the furnace, the cistern and the walls of the 40s let you create salubrious areas.

##### **C5 | Landscaping - vernacular architecture of Algarve**

###### **• BP - Latticed shutters**

The use of in the wooden shutters for protection spans a strategy is not widespread in Algarve, but suited to the climate, by the brightness control, thus

reducing heat gains and promotes ventilation without compromising the privacy of the interior spaces (AA.VV., 1980).

The architects have applied this solution on the terraces as a means of protecting the HVAC. The latticed shutters were also considered as sun protection, however, to reduce the initial investment, it is likely to be applied only at a later stage.

- **BP - Chimney**

The largest area of pre-existing architectural interest is in the areas from 1961 which corresponds to the firewood oven zone, which was recovered. As for the traditional chimney of the oven in the house terrace II it was rebuilt as the original.

- **BP - Patios and balconies/terraces**

Each housing unit from house II can use a shadowed area at ground level and another area with the role of a solarium and with ample views to the south. In house I, a balcony is shared among all housing units and with identical characteristics to the solarium and balcony in house II.

The preservation of the rectangular courtyard between the houses and the tank (Figure 3), ensuring to the set an exceptional character, in that it departs from a more urban dimension to approximate the size of a yard or rural patio (PAR, 2012).

- **BP - Spatial enhancement – “namoradeiras”**

Each housing unit consists of a living area of “namoradeira”, which is a place of rest, contemplation and transition between the outside and the inside.

The relations of the “namoradeiras” with the outside are distinct in both houses. At house I the relation is given with the outside terrace and views to the Ria Formosa (Figure 4), and in house II, the relationship is with the courtyard and the inside of the project.



**Figure 3** - Central patio / yard - linking house I, II and the tank



**Figure 4** - House I, “namoradeira”

### **From energy to atmospheric emissions**

#### **Analysis 03 | Efficiency in energy consumption and certification**

- **OI - practical guide to measures**

To improve the environmental management of the project a practical guide with measures that lead to the minimization of energy consumption by users can be made, so that they are aware of this issue can be made available in each housing unit and/or social areas of Casa Modesta for easy access to information.

#### **Analysis 04 | Passive design**

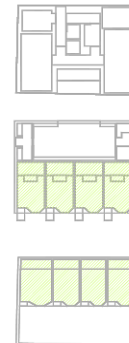
- **OI - Exterior shading systems**

The project can implement in house I shading through grapevine, solution already used in the house II, or latticed shutters, in order to increase user comfort.

- **BP - orientation**

It is considered that the best orientation of a building is along the east-west axis, with the largest glazed facade facing south (Baker and Steemers, 2002).

The tourist complex has a good orientation and proper organization of the major divisions, which allows them to be oriented south in eight of nine housing units (Figure 5) and thus indicates a good starting point to achieve a better natural lighting as well as improved thermal performance of the building.



**Figure 5** - diagram of divisions oriented south (no scale)

- **BP - Exterior openings**

According to Baker and Steemers (2000), in countries of Southern Europe, the maximum recommended percentage of glass in relation to the area of the facade, is 40% in the south (when shaded), 25% east and west and 15-20 % north.

It is then observed that the building has concerns regarding the selective fenestration with the glazed façade area with an area on south of 15%, the east and west of 7% and 14% of the north, such as an area of openings per floor area 19%.

In the case study, sealed solid wood frames are applied with an air permeability rating of Class 3. The windows are colorless low emissive double glass, with a 12mm argon fill. The bays facing south are indented and are shaded, in the house II, through deciduous vines and stairs for access to roof terraces that act as side panels.

- **BP - zenithal natural lightning – light chimney**



**Figure 6** - Vertical and horizontal zenithal openings (adapted Egan e Olgyay, 2002)



**Figure 7** - Terrace, house II, light chimney

The vertical openings (Figure 6) works best in clear skies, capturing the sunlight of low altitude and light reflected from the roof, providing a diffuse unilateral lighting and prevents glare. (Egan and Olgyay, 2002). Internally the space is fairly valued with this lighting solution, because the need for daytime energy consumption is reduced by virtue of this lighting system and the visual comfort of natural lighting is



superior to artificial lighting. In the outside, the structure allows to protect physically and visually conceal the HVAC system on the terraces of the house II (Figure 7).

- **BP - thermal inertia**

The performance of the thermal mass depends on the ability of the constructive characteristics of the building which modify the heat transfer to the space depending on the heat transfer coefficient of the material (Guedes, 2011). The thermal inertia can be complemented with thermal insulation, allowing a lower heat transfer by conduction, ideally applied continuously from the outside (Tirone and Nunes, 2007).

The Casa has opaque surroundings and internal partitions are built with solid materials, such as concrete, brick, thermal blocks, masonry. To reduce heat losses it has insulation continuously from outside.

As a result of applying this type of material, the inertia of the building is in a strong class, as stated in the verification report of the regulatory requirements of Casa Modesta (PAr, 2012).

- **BP - thermal insulation – Cork ETICS and EPS**

This strategy is adapted to the local climatic conditions and the saving of energy consumption for cooling.

The external thermal insulation ETICS (External Thermal Insulation Composite System) is adapted to the circumstances of rehabilitation, because it is more accessible to the introduction of exterior insulation into existing walls. This solution was applied to the entire project decreasing thermal bridges. At ground level and habitable areas, the thermal insulation system of outer walls is in ICB (Insulation Cork Board) of 7 cm (Figure 8), while at the terrace level the thermal insulation is in EPS (Expanded Polystyrene) of 4 cm.

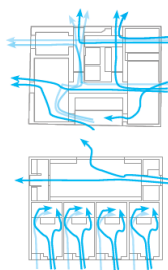


**Figure 8 - Cork ETICS**

#### Analysis 06 | Air quality levels

- **BP - cross ventilation; reducing and eliminating contaminants emission**

The cross ventilation allows the renewal of the air, improving comfort of the occupants and prevents the accumulation of contaminants (Figure 9). The removal of contaminants is achieved by using materials with low volatile organic compounds, such as lime-based coatings and not applying varnishes to the carpentry.



**Figure 9 - Part of the scheme of cross ventilation plan**

#### Analysis 07 | Thermal comfort

- **OI = A04 - shading systems**

As previously analyzed in A04, this also has impact in the thermal comfort of the occupants.

- **BP = A04 - Thermal insulation; selective fenestration**

Best practice already analyzed in the passive design, thermal insulation allows minimizing the excessive thermic bridges between the inside and the outside. Selective fenestration reflects good management of energy for lighting and reduce overheating, thus saving energy for heating and cooling.

- **BP - natural ventilation - tilt and turn windows and chimney effect**

The buildings that use passive cooling techniques can be a more efficient alternative in energy and economic terms, as an alternative to air-conditioned buildings and also offer more satisfactory thermal environments on improving physiological and psychological comfort of the occupants (Guedes, 2011).

Ventilation can be used for cooling, especially during the night. By having solar facades with different orientations, it is important to provide the windows with a tilt and turn opening system, which prevents intrusion. Ideally, in each room of the house there should be at least one inward-stop window because it allows a more effective ventilation (Tirone and Nunes, 2007).

In the housing units' windows is adopted a inward stopper and stopper glass sheet. The ventilation by chimney effect (Figure 10) exists through double openings from a single side. It is promoted due to height difference between the inlet by windows, and exit through the wooden window frames in the upper level. In the remaining spaces, cross ventilation is verified with the existence of glazed openings with different solar orientations.



**Figure 10 - Chimney effect ventilation scheme, house II**

At the close of the atmospheric energy cycle emissions, Casa Modesta seeks efficiently use of energy, through passive design and increasingly incorporating renewable energy systems.

Is worth noting the impact of the measures in the cycle because, by placing the analysis 04 of the exterior shading systems, this measure will also influence thermal comfort analysis of the 07 criteria of capacity and control C36 and in the life cycle costs C40. Air emissions are reduced by giving preference to electrical equipment over combustion, as well as the use of clotheslines and use of renewable energies such as solar thermal collector for hot water.

## ***From water to effluents***

### **Analysis 09 | Clean water consumption**

- **OI - changing sanitary systems**

Of the potential opportunities for improving the sanitary system, the most recommended to apply to the project are the flow reducers on taps and showers. To reduce fuel consumption is being already implemented an improvement to replace the use of treated domestic water for irrigation and washing floors - C16.

At the end of the water to the liquid effluents cycle the country house gets a low performance levels in potable water consumption, because few measures are implemented in that aspect. However, the analysis will be developed to the opportunity to improve by applying flow reducers, to reflect on the reduction of consumption and the economic viability of the solution. In contrast achieves an A++ performance in environmental loads by means of the effluent treatment - Biofix20 biological tank and ionization - and reusing the volume of wastewater treated.

### **C16 | Wastewater treatment**

### **C17 | Reuse of wastewater**

- **BP - Treatment of domestic wastewater by biological pit and reuse for irrigation**

The application of this active system is considered a good practice because in the study area there are no public sewers. This way one can also use the water, after being treated, for irrigation.

The maximum volume of BIOFIX 20 is 4896.00 liters. According to the study of environmental performance of the hotel industry's LiderA (2013), in terms of water consumption is 518.50 l / room / night. Then the total is 4666.50 l / night of treated water.

As the green space is a mix of 1833.10 m<sup>2</sup>, requiring an approximate irrigation of 2.50 l / m<sup>2</sup> / day (ANQIP, 2009) per day in the summer, the total water consumption for irrigation is 4582, 75 l / day. Therefore when the occupancy in the project is maximum in the summer, the efficiency is 93.60% usage rate for irrigation.

- **BP - Water from the tank treated with ionization and reused for irrigation**

The water in the tank will be treated by ionization system allowing the destruction of bacteria, fungi, algae and other harmful agents existing in the water.

The advantages of this type of treatment are reducing the use of chemicals, no water smell or taste of chlorine; preventing respiratory problems, and enables the usage of pool water for irrigation (Hidrión, 2014).

Pool water when renovated will be used to the irrigation of the garden, this option is an environmental added value by reusing a large amount of stored water, and reduce the need for water consumption for irrigation.

## ***From material to waste***

### **Analysis 11 | Waste production**

- **OI - practical guide to improve the operational phase**

This measure promotes ideas for better operation phase as the awareness of the project managers to reduce the consumption and production of materials and waste.

The approach to take is to reduce, reuse, recycle and give the most appropriate final destination.

### **C13 | Local materials**

- **BP - Local materials**

The use of local materials is one of the most relevant characteristics of vernacular architecture. In the project, the finishings are mostly ceramics and whitewashed white, due to the existence of a large area of limestone and clay soils in Algarve that facilitated their obtaining. The stone used in countertops and stone sills is breach of São Brás de Alportel.

## ***From economic diversity to the costs in the life cycle***

### **Analysis 13 | Environmental conditions of use**

- **OI - Provide environmental information of usage**

Provide a user's manual, which should be shown how to use the building passively, so guests are properly informed on how to maintain interior comfort conditions.

### **Analysis 14 | Environmental management systems**

- **BP - using the LiderA system for evaluation and certification of sustainability in construction**

The LiderA system assists in the search for sustainable design in architecture and allows taking benefit of increased environmental performance. The LiderA is a system that should be applied throughout the life cycle of the building, with special importance in the phases of design and construction.

In the case of Casa Modesta it was applied in these two initial phases having had an A evaluation during the design phase. This way, at the beginning of the construction phase, there were already integrated in the project a solid foundation for sustainable ideas and solutions being implemented.

### **C30 | Inclusive solutions**

- **BP - Accessibility for people with disabilities**

All public ground floor level areas are easily accessible. During the project implementation, the place reserved for conditioned accessibility was altered to near the entry as to allow a more direct access, opportunity for improvement suggested at the site visit, since the floor grates are not suitable for wheelchairs (Prokop *et al.*, 2011).

### **C31 | flexibility - adaptability to usages**

- **BP - Adaptability to usages – Workshop rooms**

The workshop room is a multipurpose space that can function as the guest kitchen, storage space for the organic garden products in salting and as a space for formations to external entities. In this space, the old cistern was converted into a wine cellar.

### **C32 | Economic dynamics**

- **BP - diversity in the type of room rentals**

The project Casa Modesta, despite the constructive similarity between the housing units, has a great diversity in types of possible rental space as accommodation unit, housing units with kitchenette service; two housing units with a shared kitchenette.

The flexibility of the spaces has been achieved by building the house II interior connecting doors between two housing units and the replacement of two wardrobes by two kitchen cabinets.

## **4. EVALUATION OF IMPROVEMENT OPPORTUNITIES**

### ***Analysis of the improvement, costs and payback period of the solutions***

It will be considered the improvements can be studied and quantified by comparison, through the application of analysis of the costs and economic feasibility of solutions. This way were chosen two opportunities in the energy and water

- **Exterior shading - latticed shutters**

The improvement opportunity studied is exterior shading in latticed shutters, in the south rooms on the first floor of house I, which has a cost of € 187.17 / m<sup>2</sup>, resulting in an investment of € 748.68 (PRICING GENERATOR PORTUGAL, 2014). It is analyzed adding light colored latticed shutters instead of the more economical blinds, because it falls within the desired vernacular design of the project.

For the calculation of solar gains, it was taken into account the solar radiation in the area, the area of the glass, the solar factor of the glass and of the shutters. It was considered an air conditioning with performance 3. It was determined € 8.28 saving on cooling station for four housing units.

It was concluded that the investment is not economically viable. Considering the usable life is 20 years, it has no payback in that period, it would get so an NPV of - € 624.46. However it is environmentally better reducing 54% of the applied amount of energy needed to undo the effect of warming by solar radiation.

For the calculations of global consumption reduction, knowing the energy consumed for space heating is 17% (Lisboa e-nova, 2005) it was determined an 4.08% reduction in overall consumption of the project

This shading measure didn't have the expected impact that passive design measures usually add, mainly because the project already provides other good passive design measures, such as small door and window areas, indented spans, double glass with sun protection and curtains in the inside of the Windows.

In addition, the air conditioner has a efficiency of 3, making the improvement less representative. However, the temperature reduction improves energy performance and reduces therefore the CO<sub>2</sub> that would be emitted by a greater consumption of the air conditioner, therefore there is a superior environmental performance. Thus the placement of doorways allows reducing the negative impacts of warming in summer, allows ventilation and allows regular solar gain.

The shading in LiderA system contributes to the improvement of criteria: C8 - passive design; C25 - thermal comfort; C36 - control capability; and C40 - Low lifecycle costs. So, with this improvement measure, we were able to raise the standard C8 Class A + to A ++ class, with the remaining criteria remaining unchanged.

- **Water flow reducers**

Implementation of water flow reducers in the mixer taps is indicated as an opportunity to passive enhancement, as it allows rationing consumption of this resource, avoiding waste.

The flow reducers are complementary parts of faucets to replace the traditional mesh filter. These function by emulsion, reducing the flow of water 50%. (Ecofree, 2013)

The taps are the most common consumer devices in the project, it is estimated that the faucets represent 16.00% and the shower 32.00% of the water consumption (Almeida *et al.*, 2006).

The estimates for water consumption is 518.50 l / room / night (LiderA,2013) used by guests for faucets, showers and flush toilets, which are the devices of higher consumption and utilization.

It were accounted for the consumption taps and showers, the investment cost of applying flow reducers on all devices, the savings achieved by implementing the measure and performed the analysis of the economic viability of the solution.

In parallel it was analyzed the estimated amount to be billed, including water supply, meter rental and waste collection - which are taxed depending on water consumption.

It was concluded that this investment is economically viable by reducing monthly water consumption in 37.03 m<sup>3</sup>, saving € 62.96 / month. The payback period for this measure is two years, considering that the annual maximum occupancy is 4 months from June to September. Whereas the life of



these devices is 20 years, it would get an NPV of € 3427.49 (Table 1).

The flow reducers contribute, in the LiderA system, to the improvement of criteria: C9 - clean water consumption; and C40 - Low lifecycle costs.

**Table 1** - Estimated consumption in the complex

Approximate common consumption by type of use				
	%	l/day	m3/month	€/month
Room		518,50	16,07	27,32
9 HU	100,00%	4666,50	144,66	245,92
Type of use - tourist complex				
Faucets	16,00%	746,64	23,15	39,35
Shower	32,00%	1493,28	46,29	78,70
Cisterns	28,00%	1306,62	40,51	68,86
Other	24,00%	1119,96	34,72	59,02

#### **Analysis of the life cycle costs factor**

Costs factor in the life cycle is an important parameter for the success and viability of a building, as it is a way to maximize the profitability of the building, minimizing maintenance.

With the approach performed it is confirmed that the application of the improvement solutions allows the reduction in energy consumption de 4.08% and 25.60% in the water consumption, improving the environmental performance of tourist complex (Table 2). The improvement opportunities analyzed prove to be environmentally beneficial. Only the flow reducers are economically viable.

**Table 2** - Summary of good performance indicators

Costs in the life cycle of tourist complex					
Solution	Total reduction of resource	NPV (6%)	Payback Period [years]	Factor	Class LiderA
Exterior shutters	4,08%	- 624,46 €	-	-	G
Flow reducers	25,60%	3.427,49 €	2	13,33	A++

It can be concluded that the improvement solution of the exterior shutters are Class G and is degenerative while the flow reducers is class A++ and regenerative.

Thereby is improved the operation and maintenance period which represents 80% of the lifetime of the building (Silva and Soares, 2003), also reflecting a sustainable construction that promotes sustainable development.

In short, one must assess the investment costs, the returns and the factors of the life cycle to know the advantages that the measures / solutions that the enhancement will promote in the project. This way, the placement of wooden latticed shutters is environmentally sustainable and socially but not economically, while reducing flow are sustainable in all parameters.

## **5. RESULTS' DISCUSSION**

In the first performance evaluation, with the LiderA version 2.00 system, the global class obtained is A+ (33.63%), and with the improvements referred to the class A+ (37.39%) is obtained.

In reviewing the evaluation were considered as measures of enhancement in all opportunities presented earlier and was still considered the placement of all solar collectors, another three in relation to the planned opening date.

With the summary of the analysis it can be concluded that the rise to a higher class was very difficult to happen because the classes and the overall percentage values are for A + [30%-70%] and A ++ for [70%-100%] (LiderA, 2014).

In short, the opportunities for improvement implemented have little reflection on the LiderA evaluation because despite improvements reflecting on more than one criterion, the threshold intervals are large and ascending is only reflected in environmental performance evaluation if there are already a set much higher of other good practices. The only criteria where there were observable improvements were in shading C8, the solar collectors C9 and on the availability of information and modes of use C41.

In contrast, in the prediction of consumption of resources and the cost of life cycle improvement opportunities analyzed, the measure of implementing of flow reducers on faucets and showers is the most sustainable, environmentally and economically, with a reduction in total water consumption of 25.60% and payback period of two years. Whereas the exterior shading shutters is not economically viable, despite increased environmental sustainability by reducing the total energy consumption of 4.08%. However, the investment in shutters may be offset by the return of flow reducers, allowing a positive balance.

With the analysis of the implementation of flow reducers Casa Modesta achieves a reduction of 25.60% in water consumption is achieved and the cycle of water to effluents is closed.

One advantage to take into consideration in the tourist complex is the seasonality of the project, which expects higher occupancy in the summer, which coincides with increased watering needs.

But, if due to reduced consumption of clean water by the guest or the insufficient capacity of treated wastewater in the biological tank in relation to the needs of water reused for irrigation, it is expected to be offset with the use of water from a new well and renewals of the treated water ionization pool, as irrigation needs and washes outdoor spaces can be overcome without the use of clean water.

The project of Casa Modesta rehabilitates 25% of the pre-existing building, which is the area that falls with the assumptions of fully maintain its vernacular structure of the 40s.

The assessment of sustainability under LiderA would be higher, if it obtained a higher percentage of rehabilitation - C6 and waste production information - C19, such as the preparation of a Demolition and Construction Waste Management Plan; reuse or recovery of construction and demolition waste produced. These measures allow giving greater importance to the recovery and recycling that allows rehabilitation, thereby reducing waste, preventing dumping of materials that have long lifetime.

## 6. CONCLUSION

The buildings need to be operated upon, it is essential to study ways of construction and rehabilitation with sustainable principles that take into account the environmental, economic and social performance.

Architecture can influence the sustainable use of resources in tourism, through the application of constructive measures and management systems of consumption of energy, water and waste.

This dissertation reinforces the importance of considering, in the architectural design process, measures to ensure a high environmental performance, which should be a priority on the current architecture. This way it is possible to reduce the impact of buildings on local resources and enhance the spatial quality level by using natural elements such as light and natural ventilation, making the buildings more pleasant with high levels of physical and visual user comfort which is a challenge, for those who design, to ensure these goals simultaneously.

The main objective of this study was to analyze the set of sustainable solutions applied in the rehabilitation project of the complex and identify opportunities for improvement of simple application that enhance environmental performance and have the advantage of being able to implement gradually.

The approach was to review the state of the art, it was obtained a first version of the project data and was made evaluation to know the current status. Next it was carried out a site visit where it could be clarified some issues and mapping of the current state. Finally, it was proceeded to further review the evaluation with the most updated information to be closed in the context of this dissertation and criteria were consolidated and validated after the close of the work.

In short, there was a reduction in the consumption of water and energy, closing the water to the effluents cycle, increasing the classification in LiderA.

The study of the behavior and cost associated with the implementing of improvement opportunities is useful for those involved in sustainable construction and rehabilitation industry, because it allows to evaluate the consequences of the choices made in terms of cost and performance. However the greatest

difficulty is that these improvements fit with the ideals and premises of the project.

One aspect to consider is the possibility of the varying cost of solutions, due to the increasing scarcity of resources or decreasing due to higher commercialization and distribution systems that allow a reduction in consumption.

This way, the use of such evaluations may lead to a more efficient construction of buildings as well as being more cost effective in economic terms.

As future work, in the economic analysis it could be further extended the quantification of the impacts of the analysis examined in the reduction of consumption of resources and economic feasibility of the solutions that have been described as good practices for developing design solutions. It would be interesting to do the monitoring of consumption of the building to measure real the consequences of the benefits of rehabilitation measures with sustainable construction, in terms of consumption and payback periods.

It is hoped that the work will assist in the dissemination of the ideas implemented in the rehabilitation project of Casa Modesta and that this case is a reference for promoting sustainable development of tourism in Portugal, especially in Algarve.

## ACKNOWLEDGEMENTS

To my advisor, Professor Manuel Duarte Pinheiro, for trusting me this topic, for his availability, enthusiasm and advice given throughout this work.

To PAR. Plataforma de Arquitectura, for the availability and sharing of essential information for the analysis of Casa Modesta as a case study.

To Engineer Rui Silva of YGREEN® for the support, concern and availability in the evaluation with the LiderA system.

## REFERENCES

- AA.VV. Popular architecture in Portugal. Vols. III - Region 6: Alentejo and Algarve. Lisbon: Portuguese Architects Association, 1988 (in Portuguese - "Arquitetura popular em Portugal").
- ABALOS, Iľak. "Beauty from Sustainability?" Harvard Design Magazine 30, 2009: pp.14 - 17.
- ALMEIDA, M .; VIEIRA, P .; RIBEIRO, R. "Efficient Water Use in the Urban Sector. IRAR, INAG and LNEC. "2006 (in Portuguese - "Uso Eficiente da gua no Setor Urbano").
- ANQIP, National Association for Quality in Building Installations. "ETA 0701: the use of rainwater in buildings (SAAP) Systems." 2009 (in Portuguese - "ETA 0701: Sistemas de aproveitamento de gua pluvial em edifcios (SAAP)").
- AUGENBRUE, G ; PEARCE, A. Sustainable Construction in the USA: A perspective to the year 2010. Sustainable

- development and the future of construction: A comparison of visions from various countries. CIB report 225, Chapter 14, Rotterdam, Holland: Bourdeau, L. (publisher), 1998.
- BAKER, N.; STEEMERS, K. Energy and Environment in Architecture. A Technical Design Guide. London: E & FN Spon, 2000.
- BAKER, Nick.; STEEMERS, Koen. Daylight Design of Building. Londres: James & James, 2002.
- CABRAL, Maria. "The Environmental Certification of Buildings in Portugal: the case of rehabilitation of vernacular architecture in protected areas." PhD dissertation in architecture, specialty architectural technologies, presented to the Faculty of Architecture, Lisbon, 2009 (in Portuguese - "A Certificação Ambiental de Edifícios em Portugal: o caso da reabilitação da arquitectura vernácula em áreas protegidas").
- ECOFREE. Catalog. 2013.  
<http://www.ecofree.pt/catalogos/CATALOGO.pdf>  
 (accessed 1 October 2014).
- EGAN, David; OLGAY, Victor. Architectural Lighting. Boston: McGraw-Hill, 2002.
- PRICING GENERATOR PORTUGAL. wood exterior shutter.  
[http://www.geradordeprecos.info/obra\\_nova/calculaprecio.asp?Valor=127|0\\_0\\_0|1|FDV030|fdv\\_030:\\_0\\_0\\_0\\_0\\_1\\_0\\_15\\_101\\_3](http://www.geradordeprecos.info/obra_nova/calculaprecio.asp?Valor=127|0_0_0|1|FDV030|fdv_030:_0_0_0_0_1_0_15_101_3) (accessed 10 October 2014).
- GUEDES, M. Sustainable Architecture in Mozambique: Manual of Best-Practices. 2011 (in Portuguese - "Arquitectura Sustentável em Moçambique: Manual de Boas-Práticas").
- GUEDES, M.; Pinheiro, M.; ALVES, L. "Sustainable architecture and urban design in Portugal: An overview." Renewable Energy, Volume 34, Issue 9, September 2009, pp. 1999-2006.
- HIDRION. Ionization. 2014. <http://www.hidrion.pt/pt-pt/content/ionizacao-0> 2014 (accessed 1 October 2014).
- LIDERA, Sustainable Assessment System. Practical Course in Sustainable Building. Advisors LiderA (2020) system. Lisbon: FUNDEC, Association for Training and Development in Civil and Architecture Engineering in 2014.
- LIDERA, Sustainable Assessment System. "Introduction to the Tourism Norm." Lisbon, 2013 (in Portuguese - "Introdução à Norma Turismo")
- LISBON E-NOVA. Energy Matrix of the Municipality of Lisbon. Municipal Energy Agency and the Environment, Lisbon, 2005.
- LOPES, Albino; CAPRICHIO, Lino. Quality Management Manual. Lisbon: Publisher HR 2007.
- MENDES, Sara. Photographic record of the site visit Casa Modesta. 25 July 2014. <http://web.ist.utl.pt/sara.mendes/> (accessed 25 October 2014).
- MOURÃO, Joana; PEDRO, João Branco. Principles of Sustainable Construction. Series: ITA11. Collection: Scientific and Technical Information. Lisbon: LNEC 2012 (in Portuguese - "Princípios de Edificação Sustentável")
- PAR, Plataforma de Arquitectura. Casa Modesta. Descriptive and explanatory statement. Algarve 2012. (in Portuguese - "Casa Modesta. Memória descritiva e justificativa")
- PAR, Plataforma de Arquitectura. Casa Modesta. Drawings: plans, elevations and sections. Algarve 2014. (in Portuguese - "Casa Modesta. Peças desenhadas: Plantas, Alçados e Cortes")
- PINHEIRO, Manuel. Environment and Sustainable Construction. Amadora: Environment Institute, 2006. (in Portuguese - "Ambiente e Construção Sustentável")
- PROKOP, G.; Jobstmann, H.; Schönbauer, A. Overview on best practices for limiting soil sealing and mitigating its effects in EU-27. Technical Report - 2011-50, Environment Agency Austria, 2011.
- SILVA, Vitor; SOARES, Iolanda. A Review of Projects as Means of Reducing the Cost of Construction and Building Maintenance Charges. Lisbon: Oz, Ltd., 2003 (in Portuguese - "A Revisão dos Projectos como Forma de Reduzir os Custos da Construção e os Encargos da Manutenção de Edifícios")
- TIRONE, Livia. Sustainable Construction - Each gesture Account. A new era, new paradigms and social, economic, environmental and spatial values. 15 May 2009. <https://www.youtube.com/watch?v=ax-keTfDlxQ> (accessed July 30, 2014). (in Portuguese - "Construção Sustentável - Cada Gesto Conta. Uma nova era, novos paradigmas e valores sociais, económicos, ambientais e espaciais")
- TIRONE, Livia; NUNES, Ken. Sustainable Construction. Efficient solutions today, our wealth tomorrow. Sintra: Tirone Nunes, SA, 2007 (in Portuguese - "Construção Sustentável. Soluções eficientes hoje, a nossa riqueza de amanhã")
- WILLUMS, Jan-Olaf. Challenge of Sustainable Enterprise. Guidelines for the entrepreneurs of the future. Port: First Middle Communication, SA, 2003 (in Portuguese - "Desafio da Empresa Sustentável. Orientações para os empresários do futuro").