



## The retrofitting of the Bernardas' Convent in Lisbon



Ana M.T. Martins<sup>a,b,\*</sup>, Jorge S. Carlos<sup>c</sup>

<sup>a</sup> Department of Civil Engineering and Architecture, University of Beira Interior, Covilhã, Portugal

<sup>b</sup> CITAD, Lisbon, Portugal

<sup>c</sup> c-made, University of Beira Interior, Covilhã, Portugal

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### ABSTRACT

The Monastery of Our Lady of Nazareth of Mocambo in Lisbon, usually known as Bernardas' Convent, was a Cistercian foundation (1653). In 1755 it was totally destroyed during earthquake and reconstructed later on by the Italian architect Giacomo Azzolini. After the extinction of the religious orders (1834) the Monastery had several uses. Nowadays, the monastic building serves a small condominium, a restaurant and the Puppet's Museum. As the building had to be preserved under historical regulation its unchanged exterior walls, since Azzolini's restoration, are made of solid masonry which dominates construction throughout the history. A well-known fact about this kind of buildings is their difficulty for temperature control that inevitably ends up using more energy to heat and cool, being experiencing a change in indoor climate due to different. Emphasis is placed in the thermal performance of these exterior walls from the view point of thermal comfort, following the ISO 7730 assumptions. The interior surfaces temperatures on heating season under climatic conditions of Lisbon are analysed. This paper aims to discuss, throughout a wide range of analysis, in which way the ideals and the realities of this historic building are divergent, but a factor of city growth and cultural development.

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### 1. Introduction and aims

Around the world there are thousands of old buildings that are being challenged due to reuse, modern life and higher standards of comfort (acoustic, visual, thermal, etc.). Historical buildings, unlike more recent constructions, are based up on natural products from diversities of wood to stones. They are admired due to the majesty of the old-fashioned architecture and usually found in older cities. Portuguese's cities are no exception, some of which date back to the 12th century. While a portion of old buildings maintain their initial function, as one can see in central Lisbon where there are dwellings dating back to the 18th century, others experience some kind of intervention. Old schools are transformed into different public buildings, factories are becoming museums or schools (like the University of Beira Interior) old houses are used as a new houses or offices, and so on.

Building retrofitting strategies are influenced by numerous parameters as from sociocultural to economic criteria [1]. Other important factors can also have major or minor influence on the definitive choice (energy, comfort, costs, etc.). Wang and Zeng [2] had developed a methodology to evaluate the reuse of historical

buildings. Although a sustainable retrofit of an existing building is expected to increase the market value of this building the decision still presents a number of challenges. The evaluation by the decision makers on historic buildings reuse should be supported on different expert fields, where thermal comfort must be included.

Aste et al. [3] considers that besides the  $U$  value the thermal inertia is also significant on the thermal behaviour of buildings. High thermal inertia itself may reach to 10% and 20% of heating and cooling demand, respectively. Tavil [4] has analysed the thermal behaviour of several masonry walls. It was confirmed that low  $U$  value reduces heat transfer and produces energy savings and high thermal mass reduces the exterior temperature swings on the inside. Saïd et al. [5] describes the long-term monitoring of the hygrothermal performance of a heritage house. It was once a residence now transformed into a museum with a controlled environment.

With new construction procedures, and with the help of mechanical devices, the historical buildings are transformed into a more tightly enclosure experiencing a changing in indoor climate. New challenges have emerged with the control of heat, the air flow through the building, and the moisture that outstands on higher standards of required comfort. The Bernardas' Convent, in Lisbon, is now comprised of a small condominium, a restaurant and the Puppet Museum all of which require different environmental conditions (Fig. 1). Therefore this paper aims to discuss, throughout a wide range of analysis, in which way the ideals and the realities of

\* Corresponding author at: Department of Civil Engineering and Architecture, University of Beira Interior, Covilhã, Portugal. Tel.: +351 275 329 722; fax: +351 275 329 969.

E-mail address: [amtfm@ubi.pt](mailto:amtfm@ubi.pt) (A.M.T. Martins).

### Nomenclature

$A$	amplitude
$f$	decrement factor
$h$	heat transfer coefficient, $W/(m^2 \cdot ^\circ C)$
$I$	solar irradiance, $W/m^2$
$P$	period
$q$	heat flux, $W/m^2$
$R$	thermal resistance, $m^2 \cdot ^\circ C/W$
$\alpha$	absorptivity
$\theta$	temperature, $^\circ C$
$\tau$	time, h
$\Phi$	time lag, h

### Subscripts

$a$	air
$e$	exterior surface
$i$	interior surface
$in$	interior
$max$	maximum
$min$	minimum
$o$	outer surface
$ou$	outdoor
$sa$	solar-air
$w$	wall

this historic building are divergent, but a factor of city growth and cultural development. This paper reflects also on the unchanging shell of the Bernardas' Convent, and it is ever changing and varied interior functions, in particular when it concerns to actual thermal comfort standards.

## 2. Cistercian heritage and the Bernardas' Convent

The Cistercian Order was introduced in Portugal, in the 12th century and its monasteries were associated with the development of the nation and the objectives of occupation and administration of the territory from the very beginning. The new monasteries were deployed to the image of Monastery of Clairvaux, from which

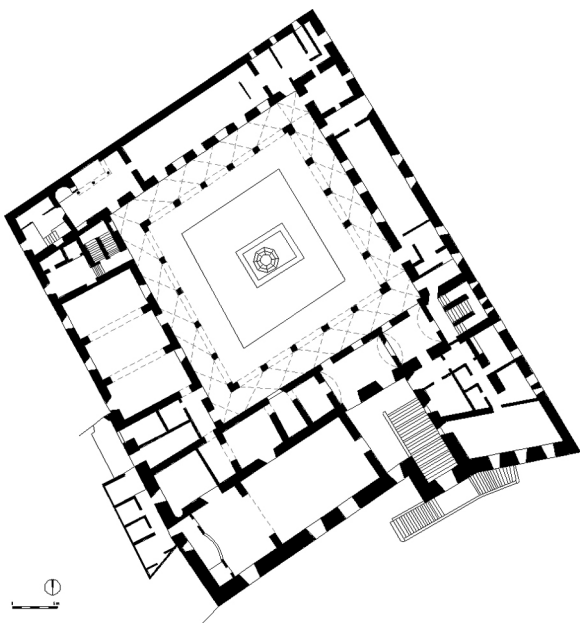


Fig. 1. Actual ground floor.

branch they provide, defining a typology of the place. However, in 1567, occurs the separation of the Portuguese Cistercians from the obedience to Clairvaux, with the creation of the Autonomous Congregation of Alcobaça.

The genesis of Cistercian architectural austerity brought in a new perspective on Art that came with the treaty of St. Bernard's "Apologia to Abbot William" resulting from a quarrel between Cistercians and Cluniacs, on the interpretation of the Rule of St. Benedict [6]. The Romanesque and then the Gothic, adjusted to the characteristics of the place, are the answer to the demands of the Cistercians, translating their spirituality. One must highlight the importance of the Cistercian Order, not only in Romanesque proliferation but also in the introduction of the Gothic, in Portugal. Portuguese Cistercian monasteries became worthy examples of the European Cistercian architecture, although over time they were adapted, enlarged and transformed according to the styles of each epoch [7].

After the extinction of the Orders in 1834, the country underwent numerous transformations and the Cistercians moved out of Portugal never to return. However, their architectural legacy was recovered and rehabilitated, evoking the ideals and the Cistercian spirituality, and does not let us forget of the importance of the Cistercian Order in Portugal. The Cistercian monasteries developed in accordance with the growth of Portugal reflecting and expressing each epoch. They were the target of numerous renovations, extensions and improvements. They also suffered from national events and disasters. Several of the Cistercian monasteries were restored using the romantic restoration ideals. The DGEMN (General Directorate of National Buildings and Monuments) applied these ideals at the beginning of the 20th century according to the theories in vogue. One of the restored Cistercian examples of this kind is the monastery of St Maria de Alcobaça that was declared a world heritage site by UNESCO in 1998 [8].

A city consists of complex relationships between both material and immaterial elements. The monastery should be seen as an ideal city, as a city of God and therefore be endowed with all the necessary elements to subsist. "The monastery should if possible, be arranged that all the necessary things such as water, mill, garden, and various crafts may be within the enclosure" [6]. Besides all symbolic connotations this is a functional and ordered place where everything has its justification. In order to understand de Bernardas' Convent (or Monastery of Our Lady of Nazaré do Mocambo – Fig. 2) we must keep in mind that the monastic space can become a territorial organism which appropriates the territory, modelling and altering it according to its needs. The building must be considered not only as an integral part and of development of an urban environment, but also, as an element of construction and management of the territory. One must not forget the vital importance, both temporal and spatial, of the monastic Orders in the development of the urban fabric of a city which in turn is included in a country. It must be taken into account that the transformation and development of the territory has been responsible for isolated buildings and settlements which have gradually been absorbed by the expansion of the urban fabric [6]. The monastery once isolated becomes integrated, interacting and forming part of the urban fabric of the contemporary city like the Bernardas' Convent.

## 3. The building's usages

The monasteries have provided the contemporary city, especially from the 19th and 20th centuries, expectant spaces or new fields of experimentation as diverse as: rehabilitation, reuse, renovation, conversion, and so, on Cano and Adell [9]. These are new spaces which adapt to new situations and new uses, in short, they update themselves, including and integrating, in its history,

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