Built Heritage Assessment and Urban Rehabilitation Flexible Criteria

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Built Heritage Assessment and urban rehabilitation flexible criteria

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Nowadays, the assessment of built heritage is an important issue in Portugal and throughout Europe, especially due to the aging and degradation of housing stock in diverse urban areas. On the other hand, the discussion of the inadequacy of current regulations to the characteristics of the existing housing stock is pertinent, and is involved with the debate on energy and social vulnerability.

This paper points out the need to apply an assessment methodology with patrimonial, technical and social standards to different urban contexts, in order to discuss the application of flexible and differentiated criteria in the urban rehabilitation procedures. The assessment methodology criteria is the result of a vast study, and arises from a comprehensive analysis of building codes and standards that support interventions on built heritage of three Southern European countries with similar cultural approaches: Italy, Spain and Portugal. These general assessment criteria are also the result of technical experts' opinion and inputs at national, regional and municipal levels over urban and building code legislation.

This assessment methodology promotes the debate on the concept of habitability, discusses the existing normative criteria and implements flexibility through an integrating social and environmental response. This discussion recognizes the importance of incorporating flexible criteria on code application, but also that such criteria should be sustained by inventorying and cataloguing processes based on multidisciplinary assessment methodologies.

Moreover, this analysis seeks to achieve the goals of the European Urban Agenda, and improve the quality of life of its residents. These results offer new inputs for the definition and optimization of intervention procedures on built heritage at national, regional and municipal levels, which could be adjusted to the climate change and multilevel governance.

Keywords: Built heritage; housing stock; assessment methodology; building codes; flexible criteria.

1 Introduction

The eminent degradation and aging of a large number of residential buildings stock in different urban areas, in Portugal and throughout Europe, results mostly from the lack of integrated national, regional and local urban policies. This situation also results

from the prevalence of fragmented studies, which do not take into consideration holistic analyses involving different problems, contexts, scenarios and scales of analysis.

On the other hand, the inadequacy and incompatibilities of the actual building codes and standards requirements to the particular construction, architectural and material characteristics of existing buildings are widespread. Several scholars are targeting the urgent need to adapt the legislation that regulate the construction sector to allow more flexible and proportional interventions on built heritage (Alonso, 2010; Asensio and Martín, 2012;Casals-Tres *et al.*, 2013; Fianchini and Fontana, 2010; García-Martinez *et al.*, 2010; Rios *et al.*, 2012).

This study shows the relevance of a systematic analysis of the codes and standards involving protection, conservation, rehabilitation and control of interventions on built heritage with similar cultural approaches (e.g. Italy, Spain and Portugal), revealing that significant changes have already been made to some of these regulations (Ornelas *et al.*, 2016a). This debate pointed out that the rehabilitation of residential old buildings should include the re-use and recycle of the existing materials, based on cultural and sustainability issues (Damla and Günçe, 2016; INE and LNEC, 2013). It also emphasizes social issues, concerned with social needs and the expectations of residents (Syed *et al.*, 2016).

It is demonstrated that the discussion around the rehabilitation of built heritage, especially directed to housing stock, converges on the need to build an assessment methodology composed by homogeneous criteria that should include patrimonial, technical and social dimensions. Consequently, the developed assessment methodology referred to as "*Metodologia de Avaliação do Património Edificado Habitado*" – MAPEH (Built Inhabited Heritage Assessment Methodology) -, is concerned to the evaluation of existing residential buildings at any context of analysis. The validation of MAPEH relies on the application of an Assessment Form (AF) to the case study of residential buildings of Porto (Ornelas, 2016).

It is also shown that the application of MAPEH on a broader context with different patterns (e.g. patrimonial/ historic value, age and cost of building construction, state of conservation, safety and housing conditions, population density, energy consumption, basic needs of residents), namely at municipal, regional and national levels, will contribute to a holistic inventory and cataloguing.

Also, this paper aims to show that a comprehensive inventory and cataloguing process of existing buildings is relevant to introduce flexible and proportional criteria on the actual application of regulations and legislation (Ornelas *et al.*, 2016a; 2016b), concerning sustainable urban rehabilitation. Furthermore, this reflection will highlight the need for guidelines that will promote a more efficient territorial cohesion, taking

into account laws that are more flexible and the application of new policies, including the discussion of climate changes issues in building interventions.

2 Built heritage assessment methodology

2.1 A systematic analysis of buildings codes

Several scholars are discussing the urgent need to adapt the legislation that regulates the construction sector to allow more flexible and proportional interventions on built heritage (Alonso, 2010; Asensio and Martín, 2012; Rios *et al.*, 2012). The requirements of building codes and regulations are mainly directed to new constructions (Arcas-Abella *et al.*, 2011; Casals-Tres *et al.*, 2010) and its application to existing/old buildings is often constrained by pre-existing conditions that make it difficult to achieve performance levels identical to those of new buildings (Fianchini and Fontana, 2010; García-Martinez *et al.*, 2010). This debate assumes particular relevance when dealing with buildings with patrimonial value, i.e. buildings that demand the preservation of their particular (cultural, architectonic, material, etc.) characteristics and contexts.

A systematic analysis of the building codes and legislation involving protection, conservation, rehabilitation and control of interventions on built heritage of three Southern European countries, with similar cultural, architectonic and climatic approaches (Italy, Spain and Portugal), allows the discussion of both different and common approaches and criteria (Ornelas et. al, 2014a; 2014b) to intervene on built heritage. In the Italian context, the national laws concerning the protection of cultural heritage and the intervention on built heritage promote the creation, at the regional level, of general and uniform guidelines for all regions, with few exceptions. At the municipal level, this approach consents, based on inventory and cataloguing processes, the establishment of clear criteria to classify built heritage and the creation of degrees of intervention adjusted to the different building categories. In the Spanish context, there are national laws concerning the protection of historic heritage, and a building code, which is being adjusted by public institutions to establish proportional and flexible intervention criteria. Each region creates their own laws concerning specific criteria for classification and cataloguing, as well as different measures associated to different levels of building classification to intervene in built heritage, not following a unified process. The housing condition requirements are established at the municipal level and the measures of conservation and rehabilitation are related to criteria stipulated at the regional level. In the Portuguese context, on the other hand, the national laws concerning the protection and classification of cultural heritage are discrete and diffuse and do not promote the establishment of unified databases to classify built

heritage, as there are disperse inventory and cataloguing processes established by different entities. Moreover, without regional directives and the lack of guidance from the national building codes and legislation on how to intervene on built heritage (Ornelas *et al.*, 2014b), the intervention procedures are evaluated at the municipal level with national technical/code support (Ornelas *et al.*, 2016a).

This comparative analysis found gaps in the Portuguese legislation and showed the need to create an integrated methodology to define effective intervention guidelines and criteria to adjust the actual buildings codes and standards to the interventions on built heritage. It showed the importance of inventory and cataloguing in this process, as a fundamental tool for establishing levels and measures of intervention. The experts from governmental, municipal and academic institutions in these three countries, when interviewed, underline that the implementation of building codes and regulations has more success when supported by flexible and proportional criteria that take into account the built heritage and its intervention context (Ornelas *et al.*, 2016b). In particular, the comparison of building codes and legislation points out the need for an integrated assessment methodology, i.e. a more holistic knowledge with general criteria that allows evaluating the patrimonial, the technical, but also the social dimensions of built heritage. The evaluation of residents' profile, perception and basic needs is also pointed out by experts as being part of an all-inclusive assessment process of built heritage (Ornelas *et al.*, 2016b).

2.2 A holistic assessment of built heritage

The evaluation of inhabited building stock is important nowadays, as its aging and degradation in diverse urban areas, both in Portugal and throughout Europe, especially in historical centres and central urban areas, is a rather important issue. Several analyses assess the major causes of degradation of built heritage in different contexts and different dimensions (Aitziber, 2015; Vicente *et al.*, 2015; Zabalza *et al.*, 2011). The sustainability of buildings is a multidimensional concept, often focusing solely on environmental indicators, ignoring economic and cultural indicators, as well as the social and patrimonial indicators (Damla and Günçe, 2016; INE and LNEC, 2013; Oleg *et al.*, 2015; Pombo *et al.*, 2016; Ricardo and Bragança, 2011; Tiina *et al.*, 2015; Ulisses and Ghisi, 2016; Zabalza *et al.*, 2011).

Some studies demonstrate that the impact of construction products can be significantly reduced by promoting the use of the best techniques available, replacing the use of finite natural resources for waste generated in other production processes, preferably available locally (Zabalza *et al.*, 2011). Some methodologies compare retrofitting solutions, combining Life Cycle Assessment (LCA) and Life Cycle Cost

(LCC) to evaluate environmental impacts in monetary values (Pombo *et al.*, 2016; Zabalza *et al.*, 2011). In addition, the LCA appears as a renewable approach to assess the environemntal sustainability of different production alternatives (Ricardo and Bragança, 2011; Ulisses and Ghisi, 2016). The social dimension is also included in the LCA analyses. Some authors underline the assessment of health and well-being of residents (Langevin *et al.*, 2013), emphasizing the need to evaluate their behavior in dwellings, especially in buildings with high density, and their perception, through personal interviews of comfort in housing, taking into account their satisfaction and health condition (Casals-Tres *et al.*, 2013; Castellano *et al.*, 2016). This analysis is connected both to energy consumption and social needs; highlighting the social vulnerability of residents associated to low-incomes and low education levels (Langevin *et al.*, 2013).

Recently, energy and thermal comfort in the building stock has become a high-interest topic among scholars. Retrofitting buildings to current energy efficiency and thermal comfort standards is essential for improving sustainability, energy performance and for maintaining the built heritage of historic structures (Häberle *et al.*, 2014; Martínez-Molina *et al.*, 2016).

Additionally, some studies focus on the current concept of habitability in relation to the environmental impact and discuss the importance of redefining it as a social demand. This debate is associated with the need for a more targeted regulation of the housing stock that includes more flexible and pluralistic housing concepts that encompass the urban scale (Arcas-Abella *et al.*, 2011; Casals-Tres *et al.*, 2013). The need to provide adjusted and proportional conditions to the socio-economic requirements of the different resident profiles, following the European agenda, is demanded to reduce energy consumption (Ávila *et al.*, 2013; Castellano *et al.*, 2016; Langevin *et al.*, 2013).

These studies highlight the need to implement an assessment methodology that assess built heritage, taking into account, simultaneously, its patrimonial, technical and social dimensions, and to promote its rehabilitation following adjusted and accurate procedures. Consequently, the creation of MAPEH (Ornelas, 2016) emerge from the need to evaluate different urban housing stock contexts.

3 An assessment methodology for inhabited built heritage

3.1 Presentation of MAPEH

The comparison between buildings codes and legislation concerned with the urban rehabilitation procedures of three Southern European countries (Italy, Spain and Portugal), concerning the protection, classification and intervention on built

heritage, highlights the importance to introduce general and homogenous criteria in the assessment and classification of built heritage (Ornelas *et al.*, 2016a). The MAPEH is an integrated methodology that combines the patrimonial, technical and social dimensions (see figure 1). This methodology can be adapted to different urban areas, contributing to identify different problems of the building stock in Portuguese territory, as well as in other countries. These procedures are relevant to create approaches and guidelines directed to regional, inter-municipal and local levels, taking into account multidisciplinary characteristics of different patterns of the building stock (patrimonial value, age and cost of building construction, state of conservation, safety and housing conditions, population density, energy consumption, basic needs of residents). In this way, the MAPEH is a methodology that allows the construction of a holistic view on the buildings condition.

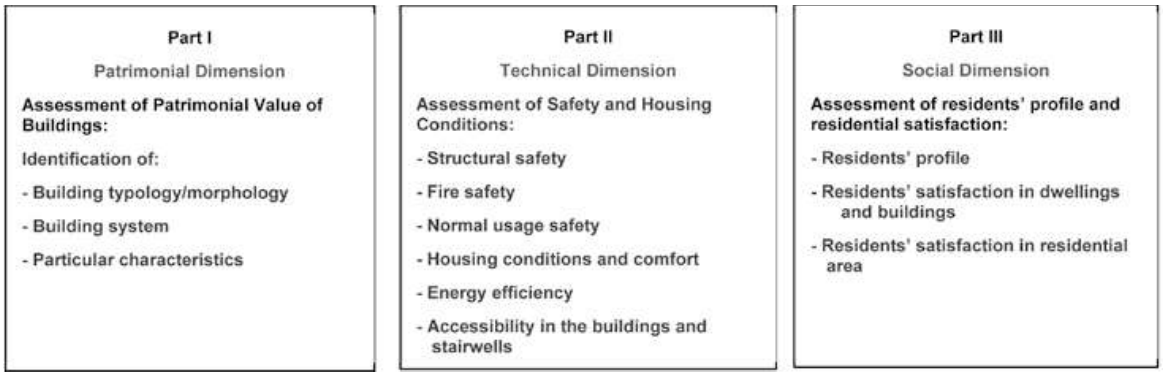

Figure 1. The criteria of patrimonial, technical and social dimensions of MAPEH.

3.2 Operability of MAPEH to old residential buildings of Porto

The application of MAPEH to a specific context is done through an Assessment Form (AF) that converts the general criteria of MAPEH to the criteria of the specific context of analysis. This procedure is supported by the technical and scientific knowledge of experts from the different areas involved (Ornelas *et al.*, 2016b), and by bibliographic research of codes and regulations.

The AF is the main operational tool of MAPEH, and has the same tripartite configuration of MAPEH. Its construction involves the adjustment of the Portuguese regulatory parameters and requirements to the characteristics and features of the old residential buildings of Porto, a process that requires technical knowledge obtained mainly through the support of multidisciplinary teams of experts. The different parts of the AF are composed by quantitative and qualitative parameters/items.

Therefore, the first part of AF evaluates the building's patrimonial value (typology and morphology), constructive systems, material and techniques (stonework, carpentry, stucco, etc.) and the characteristics that add patrimonial value, either from the exterior

(volume, facade, skylight, balcony, etc.) or interior (wall lining, flooring, ceiling, stairwell, etc.). The second part is concerned with the assessment of safety (structural, fire and usage) and housing conditions (compartments dimensions, functionality, comfort and accessibility), taking into account the Portuguese building codes and regulations as reference criteria. The third part is related to the social dimension and consists on a questionnaire directed to the representative of each family living in the buildings. It contains questions related to the residents' profile and their residential satisfaction concerning the physical characteristics of the dwellings (see figure 2).

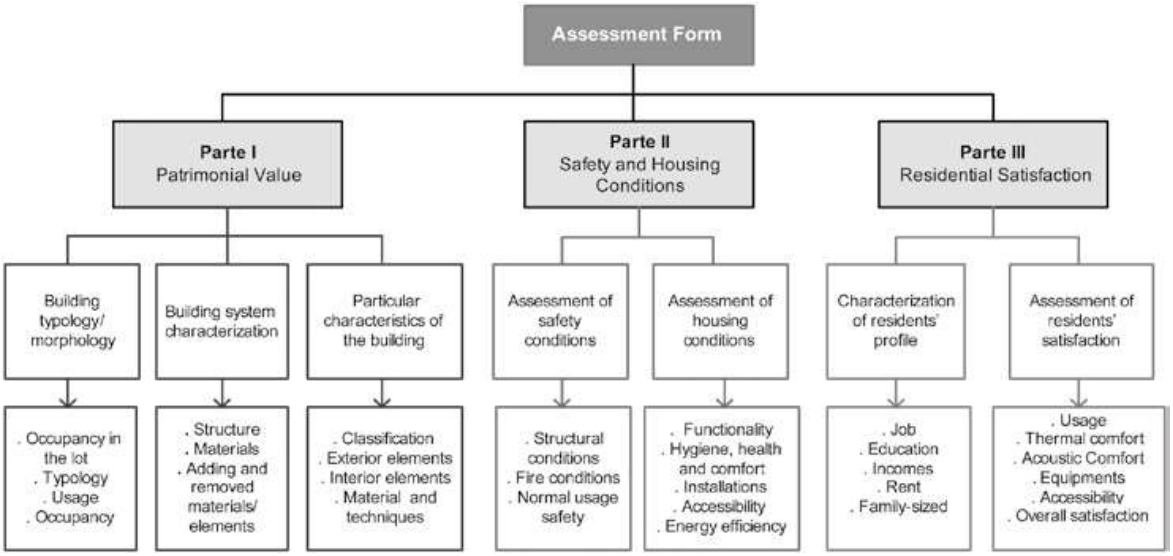

Figure 2. The configuration of AF.

3.3 Validation of MAPEH

To make a comprehensive analysis/diagnosis of the case study, it was first necessary to transform the qualitative data collected by AF into quantitative data.

The quantitative database allows comparing, in percentage, the behaviour of the patrimonial, technical and social dimensions. The data processing enables the identification of the elements with major contributions to the patrimonial value, the most important and common anomalies related to safety and housing conditions, and the most relevant expectations and needs of the residents (see figure 3). In particular, this diagnosis reveals that this built heritage has high patrimonial value, considering its particular exterior (e.g. volumetric, facade and windows frames) and interior elements (e.g. flooring, ceilings and stairs), and its used material and construction techniques (e.g. stonework, carpentry and stucco).

However, water infiltration, especially through the roof, and the material degradation of structural and non-structural walls, roofs and stairs are main anomalies involved in the evaluation of the buildings safety conditions. The addition of interior compartments

(e.g. bathrooms and kitchens), the lack of ventilation and the presence of mold and spots resulting from surface condensation are important anomalies that contribute to the poor housing conditions of these buildings.

These aspects are also reflected in the analysis of the social dimension, which reports a negative perception of the residents concerning their housing conditions. In particular, the residents' express negative perception regarding their housing thermal comfort and accessibility, but a positive perception about the patrimonial value of their buildings. Finally, the inquired residents are mostly elderly people who live alone, living in the same dwelling for more than 30 years. These residents also have low incomes and low rents, as well as low education levels (see figure 4).

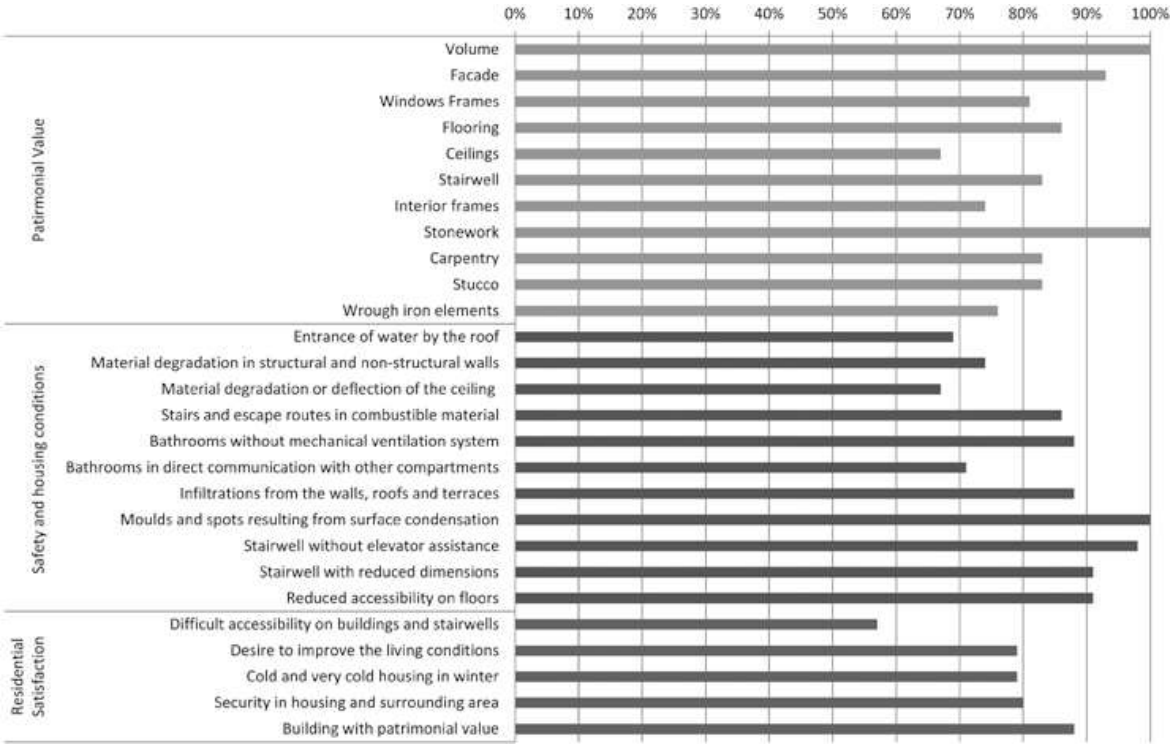

Figure 3. Results of the assessment of the patrimonial, technical and social dimensions of the old residential buildings of Porto.

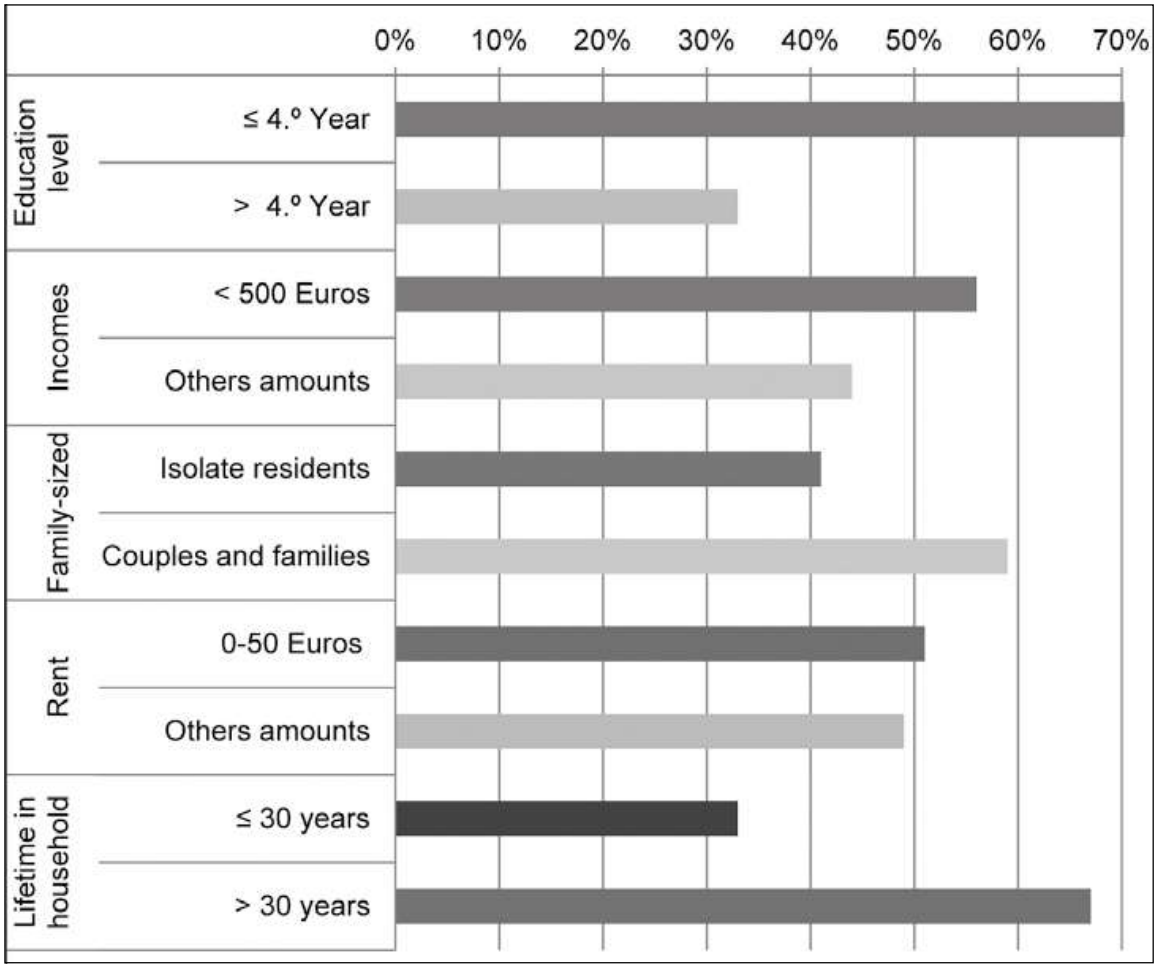

Figure 4. The socioeconomic residents' profile.

The transformation of singular qualitative replies into qualitative values is done by associating binary variables ("0" and "1"), where "1" corresponds to the quality indicator status. It was also necessary to assign weights to each unique parameter, which was accomplished with the support of experts´ opinion. By giving weights between 0 and 3, so that each group of thematic quantitative parameters could be joined in "global variables", namely: patrimonial value, safety conditions and housing conditions, this allowed the characterization of the sample's profile. Through this analysis, a qualitative/quantitative assessment of the patrimonial value and of the safety and housing conditions was also achievable (see table 1) through the division of the interval [0,00; 3,00] into four equal parts. As an example, buildings evaluated between [0,00; 0,75[have low patrimonial and very poor safety and housing conditions. Buildings with values between [1,50; 3,00] have acceptable safety conditions and basic housing conditions.

Table 1. Qualitative and quantitative assessment of case study buildings.

Qualitative/quantitative assessment of case study buildings				
Values of the intervals	[0,00; 0,75[	[0,75; 1,50[	[1,50; 2,25[	[2,25; 3,00]
Patrimonial Value	Low	Medium	High	Very high
Safety Conditions	Not acceptable		Acceptable	
	Very poor	Poor	Reasonable	Good
Housing Conditions	Not Basic		Basic	
	Very poor	Poor	Reasonable	Good

Buildings were also classified in four distinct classes, arranged by decreasing order of patrimonial value, from A to D. In particular, figure 5 shows that there are buildings with quite different safety and housing conditions within each class, meaning that there is no correlation between the patrimonial value of the buildings and their state of conservation. This demonstrates that the high patrimonial value of some buildings did not imply a special attention by the owners or the public entities.

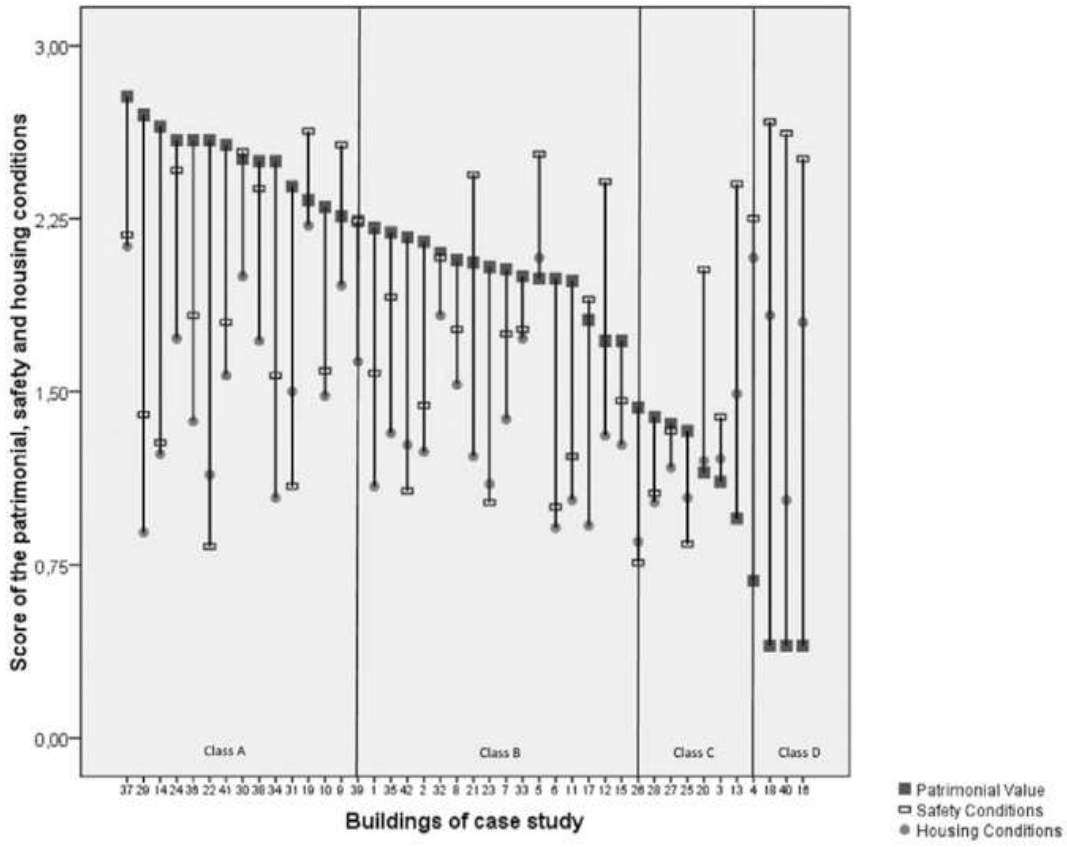

Figure 5. Classification of the old residential buildings of Porto into classes.

The application of MAPEH to the old residential buildings of Porto highlighted the potential of the methodology for collecting detailed and integrated information, which can afterwards be oriented to cataloguing processes. Moreover, the data processing within MAPEH allowed measuring and quantifying the patrimonial value and the safety and housing conditions of these buildings, as well as connecting the residential satisfaction of the residents and their basic needs to the physical characteristics of the dwellings. Moreover, it has shown that there is no correlation between the patrimonial value and safety and housing conditions, as there is a wide variability of these conditions within buildings with similar patrimonial values. This means that buildings with higher patrimonial value do not have a different/ better treatment than buildings with less patrimonial value.

3.4 Levels of interventions

The analysis of the building classes highlights the importance of defining targeted intervention levels directed and adjusted to the patrimonial, technical and social characteristics of the buildings, making MAPEH an essential tool in this process. In Portugal this approach is emerging (Freitas, 2012; LNEC, 1990), but still without the support of a wide inventory and cataloguing process (Ornelas *et al.* 2016a). In other countries (e.g. Italy and Spain) the levels of intervention are supported by current legislation criteria and, hence, by inventory and cataloguing processes (Rios *et al.*, 2012; Rumor and Gonzato, 1989). Considering this, the MAPEH can propose three possible levels of intervention (see figure 6).

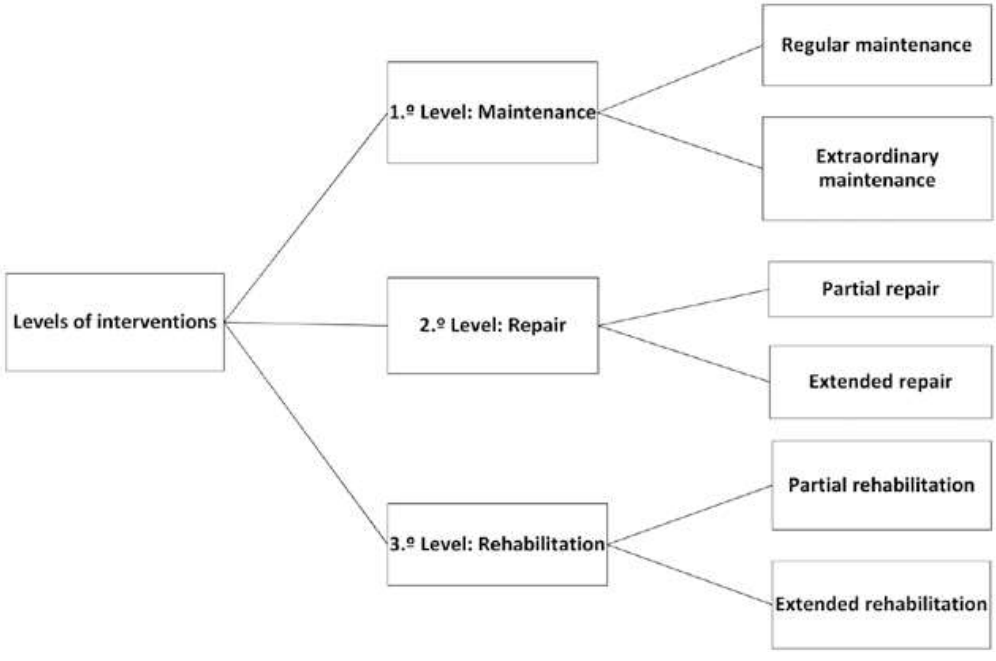

Figure 6. Levels of intervention on built heritage.

The first level includes all maintenance actions, directed to all buildings and that should be applied transversally. It regards actions of regular maintenance, considering all preventive operations, which are actually demanded by current regulations. This first level also includes extraordinary maintenance measures focused on existing installations and equipment. Actions in this category include, for example, fixing small cracks on walls, walls and floor linings.

The second level of intervention includes all repair actions, which are not necessarily included in the maintenance category. These actions are targeted to return the buildings to their previous condition, before the occurrence of such anomalies. It includes measures such as: interventions in flooring, stairwells and infrastructures (e.g. water supply, pluvial drainage, etc.). This category is divided into partial and extended repairs, where it involves less or more than 50% of the building, respectively.

The third and most complex level of intervention - rehabilitation -, assumes the need for deeper actions. According to the criteria and procedures mentioned in the legislation, this type of measures intends to improve safety and habitability conditions, improving the buildings' functionality that suffered from aging or poorly executed interventions. Depending on the buildings conditions and necessary workload, it is possible to have partial or extended rehabilitation interventions. Actions in this category include the replacement of walls, ceilings, flooring, stairwells, sanitary and kitchens facilities, or general infrastructures such as mechanical ventilation systems, exhaust ducts, sewer installations, pipes for water supply and pluvial water drainage.

4 Urban rehabilitation and flexible criteria

4.1 Urban contexts of analysis

Since MAPEH is an assessment methodology concerned with inhabited built heritage, it can be adjusted at any context of analysis. This debate highlights the urgency to evaluate the inhabited housing stock in different urban areas with diverse configurations and problems (e.g. old historic residential buildings, social housing, dwellings of the 70's and 80's, etc.).

The Portuguese national census (INE, 2011; INE, 2012) already provide some insights regarding the overall building condition in national territory (see figure 7 and 8). However, this information is fragmented and scarce to allow a wider debate on the application of normative criteria in urban rehabilitation. In particular, figure 7 shows that there is no direct correlation between population and housing density, as well as the state of conservation of buildings. On the other hand, these results

show that there is a strong connection between the age of buildings and their need of repairs (see figure 8).

Figure 7. Population density, buildings density and state of conservation of buildings in Portugal (INE, 2011, p. 19, 66 and 69).

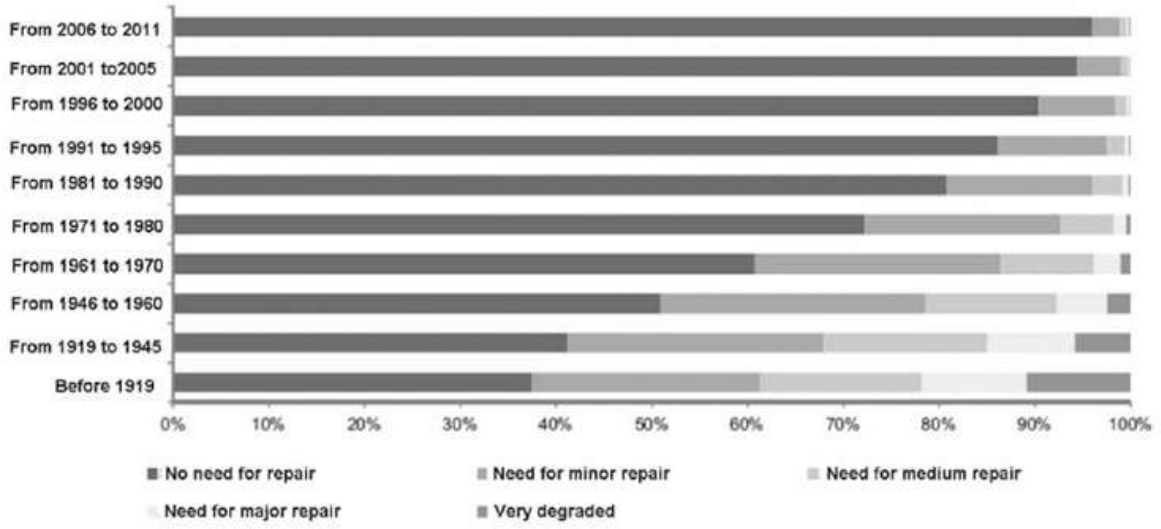

Figure 8. Different building construction periods in Portugal and their need to repair (INE, 2012, p. 34).

In order to complete this characterization, there is a need to identify different housing stock that combine patrimonial, technical and social dimensions. The application of MAPEH should be applied to buildings with different materials, constructive techniques, and to particular characteristics of buildings, different periods of construction and constructive systems (from diverse regions of Portugal). Also, it should include diverse safety (structural, fire and normal usage parameters) and housing conditions (building compartments dimensions, functionality, accessibility and thermal comfort related to the building features), as well as taking into account the population density and different socioeconomic profile of their residents.

4.2 Flexible criteria

The wide-ranging application of MAPEH to different urban contexts, considering diverse scenarios of housing stock will mature a wider discussion and implementation of flexible and differentiated criteria application at urban rehabilitation procedures. This debate is relevant to bring inputs to the Portuguese context, as the actual building codes and regulations in Portugal are mainly concerned with new constructions, discarding the particularities of old buildings, and there is no inventory and cataloguing support for a flexible application of MAPEH. As mentioned before, in other countries (e.g. Italy and Spain) the levels of intervention are already supported by current legislation criteria and, hence, by inventory and cataloguing processes (Rios *et al.*, 2012; Rumor and Gonzato, 1989).

Regarding Spain, it is important to point out two criteria established by the building code - *Código Técnico de la Edificación* - (CTE): proportionality and flexibility. The first criterion aims setting a level of intervention that is reasonable when confronted with the dimension and context of the intervention (repair, renovation, change of use, extension). The criterion of flexibility, on the other hand, exists to overcome code requirements in order to allow higher levels of heritage safeguard, or interventions more suited to the particular characteristics of the constructions and/or to the dimension and context of the intervention (Ornelas *et al.*, 2016a). The figure 9 shows that an intervention should improve the actual conditions of a building, without having necessarily to fully comply with the requirements of codes. While the treatment of such requirements should be homogeneous, the application should be different when applying safety or housing conditions requirements. There are minimum safety requirements that cannot be avoided as they affect the safety of people and their universal rights (Rios *et al.*, 2012).

Actually, an intervention should improve the actual conditions of a building, in particular, codes should include more flexible and proportional criteria, depending on the context of each intervention (Ornelas *et al.*, 2016a). In this regard, MAPEH can also be an important tool to support the creation of those levels, i.e. it can be a tool to support the creation/application of new codes criteria. In addition, such approach implies the establishment of different levels of adequacy depending on the evaluation of the buildings patrimonial, technical and social dimensions, which should be associated to different levels of intervention.

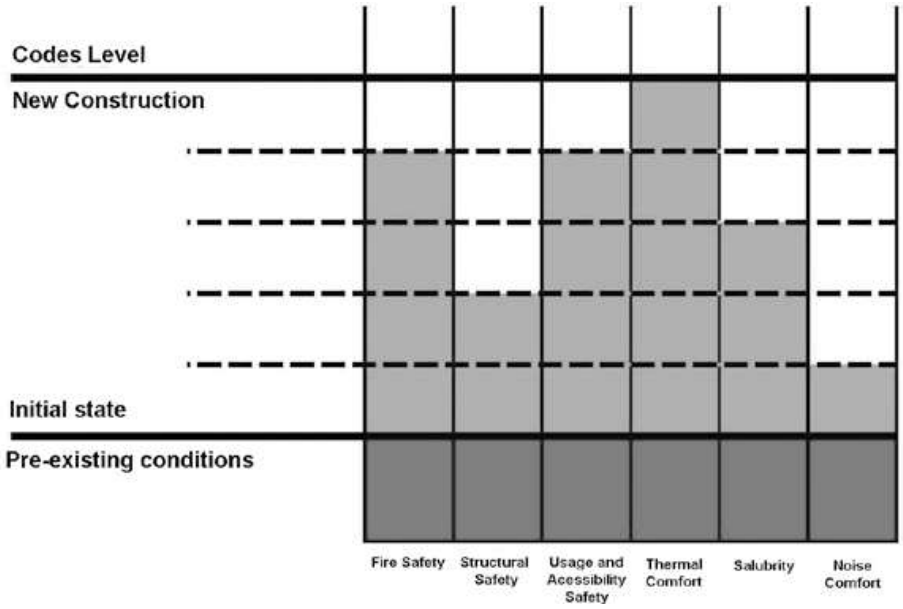

Figure 9. Global scheme of intervention in existing buildings (Rios *et al.*, 2012, p.5).

MAPEH is concerned with the evaluation of housing stock in order to optimize the available resources, while maximizing the outcomes of the intervention in cultural, technical, social and economic terms. Consequently, MAPEH is an assessment methodology that could contribute to close the material cycles, when fostering the reusing of existing materials, while contributing to a natural reduction in energy consumption and greenhouse gas emission (see figure 10).

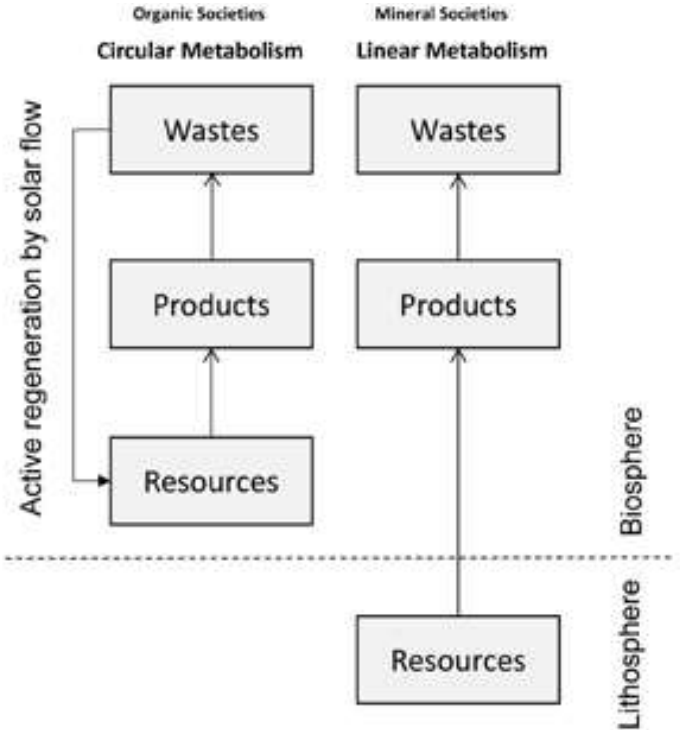

Figure 10. Circular and linear metabolism (Arcas-Abella, 2013, p. 4).

The redefinition of the concept of habitability should be connected with closing material cycles, and consequently, linked to precise resources to be maintained over time (Arcas-Abella *et al.*, 2011). In addition, the built heritage is one of the main components of the urban fabric of older European cities, and consequently any transformation of the model of habitability must be approached from the rehabilitation of its existing stock. In this context, the broad evaluation of housing stock through the MAPEH encourages the debate on the implementation of good rehabilitation practices on housing stock, which will respond to the recent European agenda (2016 and 2017), by improving the quality of housing.

5 Conclusions

The systematic analysis of codes/legislation highlights the importance to introduce general and homogenous criteria to support the assessment of built heritage in general; but also that this should be complemented by approaches and guidelines directed to its regional and local features in order to ensure interventions closer to the built heritage characteristics (patrimonial, technical and social). Therefore, the urgency of this analysis arises from the inadequacy of the current regulations to the characteristics of the existing housing stock. It becomes fundamental to discuss urban rehabilitation criteria at different contexts of analysis.

The application of MAPEH to a broad context of analysis could be a contribution to a complex inventory and cataloguing process of different housing stock at national and regional levels, as well as to the debate on the concept of habitability. The inventory and cataloguing of housing stock will establish a broad and well-founded debate on different normative criteria in the legislation, regulations and building codes, aimed at the rehabilitation of the housing stock. In this process, it will consider different levels of intervention to a well-oriented adaptation of legislation (e.g. climate changes regulations). Governance should increase levels of interventions suitable to the inventoried and catalogued scenarios, and improve the flexible application of legislation and regulation, taking into account other relevant issues such as climate change impacts.

A guide for intervention on built heritage can be developed by MAPEH to prevent further built heritage loss and contribute to a greater territorial efficiency in urban rehabilitation. Each region should, as a consequence, have its own inventory and cataloguing system in order to create well-oriented guidelines adjusted to its built heritage.

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