Conservation level of residential buildings: Methodology evolution

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HIGHLIGHTS

- A method to assess and improve building condition assessment was developed.
- Buildings' degradation methodology correlates failures, deterioration and the performance level.
- The methodology application aims to prioritize the refurbishment and maintenance interventions.
- Contributes to decrease the premature and general degradation of buildings.

ARTICLE INFO

ABSTRACT

Buildings' degradation is a real concern of owners. The early deterioration of public and private buildings reflects the low durability of their constructive solutions. Most of those contribute to the no compliance with the estimated service life of the entire building or of its parts, leading to the need of extraordinary refurbishment actions and to a wide waste and consumption of resources.

An evaluation methodology to estimate the buildings' degradation level identifying the causes of the anomalies and the refurbishment solutions to achieve more quality and durability of buildings' envelope was developed. The assessment of the conservation state of a set of social housing through visual survey allied to evaluations scales was carried out. Since the methodology revealed useful and adequate to any constructive system it was subject of changes to get more objectivity, flexibility and reliability in its application to different type of buildings. Therefore, a review of the evolution of this methodology was done. This paper aims to analyse the evolution of this degradation assessment methodology, to show the improvements introduced, providing insights into this method and outlining the most important directions for future research. It is concluded that currently the method is easier to implement and lead to more consistent and reliable assessment results.

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1. Introduction

According to CIC [10], a building survey is an investigation and assessment of the construction and building condition including the structure, fabric, finishes and grounds. Building condition assessment is a complex task, requiring knowledge, time and equipment [33]. This process includes developing a performance report, establishing building serviceability, planning for maintenance or repair, verifying code compliance, safety, durability, historic preservation and functional requirements. Therefore, the need for accurately assess the building condition has become more important as failures can result in safety and health problems, as well as, structural damage [2,27].

The building condition assessment consists on a systematic registration of the entire building, element by element. The detected damaged is evaluated on a scale with pre-defined criteria, and this assessment is implemented by visual technical inspections [33].

Building inspection is an important tool in determining building degradation state by detecting defects and their symptoms. A quick and practical approach needed to perform periodic building inspection and to evaluate its degradation level is essential [9]. It allows a systematic observation of the building and is essential to find out the degradation level and to suggest adequate refurbishment proposals and appropriate maintenance actions. It also contributes for the improvement of buildings' energy efficiency [37].

Several methodologies to evaluate building envelope's failures have been developed. Almost all the used scales have four or five

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degrees and some were developed to give the conservation level, evaluating the building repair needs based on visual survey, such as:

Portuguese Urban Tenancy Regime – NRAU, developed by the National Laboratory of Civil Engineering (LNEC), and the Portuguese method for buildings condition assessment – MAEC [28,46]. This methodology has a five-level scale to give the building condition assessment. Is a multicriteria assessment based on: damage consequences in functional requirements; work type and extension to correct the damage; relevance of the damaged areas; existence of alternative for the space and equipment affected.

The method of valuation of building conservation state with conditional rental is a method for building condition assessment published by the decree-law n° 329-A/2000, of 22 of December [35], being its support assessment methodology based on visual inspections. Is a multicriteria assessment considering the repair requirements and the building components that need performance improvement [35]. However, this methodology is restricting, since is applied just of residential buildings under a conditioned rental regime. Besides that, this method takes into account the safety requirements and esthetical aspects [35], but it does not take in consideration hygiene and health requirements, as well as, the comfort and use requirements.

Following the Municipal Code of buildings' Tax (IMI in Portuguese), a methodology of building condition assessment was developed, also based in technical visual inspections. This methodology gives an objective evaluation; however, it gives guidelines just about what constructive elements should be assessed, without any evaluation criteria [36].

Other methodology developed in Portugal is the methodology of certification of minimum conditions of habitability aiming to verify the fulfilment of safety and health requirements of buildings and its functional demands [34], also based in visual inspections. However, the evaluation stablishes absolute minimum values that constructive elements and functional elements should accomplish, leading to a simplification of the methodology in which is just necessary comply with the minimum requirements of the building.

The methodology of diagnosis to support refurbishment of residential buildings is another method based on visual inspections to evaluate the building condition [24]. This one compares the performance of the existent constructive elements with performance requirements stablished in the standards and guidelines, collects previous information and entails contact with clients/inhabitants through interviews. However, the building condition assessment is based on the accomplishment of the performance requirements, which is a disadvantage when applied to historical buildings. In these cases can collide with the preservation of the historical heritage and can increment the refurbishment costs [25].

Determination of the dwellings conservation coefficient is a method of building condition assessment based on an evaluation method of buildings' conservation state under conditional rental and on MAEC. This methodology developed in 2007, includes the constructive elements to verify and the evaluation criteria and proceedings for objectively assess buildings. The elements evaluation is more objective, but continues to just concern with repairs for performance change [35,22].

A method to assess the refurbishment needs developed by LNEC in 2007, considers safety, hygiene, comfort, health, use requirements and urban insertion. It verifies the dwelling refurbishment viability and the correspondent level to achieve established housing conditions. Defines the individual conservation state of the dwelling, providing a complete characterization of the building condition including the influence of the urban surroundings. However, its assessment scale levels are subjective and need a diagnosis that allows more definition of the intervention type to be implemented [45].

Other scales for buildings' degradation graduation based on different criteria were developed. This methodologies can be based on the extension of the damage, like Socotec [43], combining damage extension and frequencies, such as Marteinsson and Jónson [26] or combining severity and extension, like Lounis et al. [23], Gaspar and Brito [20], Teo [44], Gaspar et al. [21], Shohet and Paciuk [42].

Other methodologies based on visual inspections were developed, such as, the Home Condition Report developed in 1998 in UK [12]; Housing Health and Safety Rating System developed in 2000 in UK [13,32]. Condition Assessment of Buildings under the risk to be declared unhealthy developed in 2003 in France [18]; Housing Degradation State Assessment Grid applicable in 2006 in France [1]; Diagnostic Technical Dossier in 2005 in France [19]; Netherlands standard for evaluation of building conservation state NEN 2767 in 2006 [29,30,31]. Energy Performance Indoor Environmental Quality Retrofit – EPIQR [3,4]; Tool for selecting Office Building Upgrading Solutions – TOBUS [7] and XENIOS [11] (EPIQR, TOBUS and XENIOS are diagnosis tools for decision support about buildings' refurbishment interventions that were developed following research projects in several European countries); Habitat Heritage Report developed in 2011 by QUALITEL Association in France [8]; Buildings' Technical Inspection developed in 2008 in Spain [41]; Homebuyer Report implemented in 2009 in UK by RICS [40].

However, the valuation of the detected degradation causes and the relationship between the deterioration state of the analysed elements and their performance level is not considered in any of these methods. To answer this, Rodrigues [37] developed the state of conservation assessment of residential buildings at controlled costs – SCARBCC methodology. Through the building envelope inspections and through the data collected from users' interviews, this method allows achieving the building degradation level of each element under assessment [39]. This methodology includes an observation matrix, a graduation scale and a field sheet to fill. To support the visual survey, observation matrix applying the Failure Mode and Effects Analysis (FMEA) were developed to analyse the principal causes and effects of the identified anomalies. FMEA allows finding the relationship between the deterioration state of the analysed elements and their performance level. It is based on an interactive principle: the direct or indirect effects can become the causes of other degradations, giving the possibility of identifying almost all the possible failure modes of the element [38]. In this matrix is registered the main symptoms of the anomaly, its causes and consequences (direct and indirect). The graduation scale presents the conditions defining the Degradation Level (DL) for each element, and the field sheet is where it is registered the information collected during the visual inspection. From these collected data, it is possible to define each element DL that reflects the anomaly severity, both in terms of extension and in terms of gravity being possible to establish intervention priorities in the building stock. The method developed by Rodrigues et al. [38], aggregate the DL results allowing the determination of the Evaluation Index (EI) of the building envelope. These data enable to define the building degradation state that is the goal of the methodology. In spite of its applicability, Vilhena (2011) considered that the height levels of the assessment scale as the high number of conditions established might lead to confusion in the methodology application. Therefore, Di Prizio [14] developed the methodology to simplify its application as showed in the next section. The aim of this paper is to analyse the SCARBCC methodology evolution and throughout its implementation to a real case study show its practical applicability.

This work is very relevant, and the refurbishment and maintenance of buildings' sector has a high potential growth, since in Portugal there are more than 1 million of buildings with refurbishment needs [22]. The development and improvement of