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Comparison of Methods Used in European Countries to Assess Buildings' Condition

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ABSTRACT

This paper presents a comparative analysis of methods used in European countries to assess buildings' condition. The following methods were compared: a Portuguese method to assess buildings condition, an English housing health and safety rating system, a French method to assess buildings that may be declared inhabitable, a Dutch standard about buildings condition assessment and the assessment methods developed within the European projects EPIQR & TOBUS. The comparative analysis included three tasks. First, each of the methods was described separately. Then, the main features of the methods were compared. Finally, some guidelines to improve the Portuguese method were drawn.

The main differences of the methods are the objectives and scope of the assessment, the disaggregation level of the global assessment, the calculation formula used to aggregate partial assessments, the type final results obtained and the tools developed for their implementation. The main similarities are that the assessment is carried out mainly by visual inspection, the condition of the building is assessed by a systematic analysis of the entire building divided into functional elements, the severity of defects is the assessment criterion used, weighting coefficients are used to determine the importance of each partial assessment in the final result and surveyors need specific training.

The recommendations about the Portuguese method are to maintain the present assessment model, to carry out the training courses of surveyors, to create a complementary tool for the diagnosis of the causes of defects and to develop a computer program to support surveyors during inspections.

KEYWORDS

Building pathology, Condition assessment, Buildings condition, European methods.

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1 INTRODUCTION

The assessment of a building's condition is a technically complex task, requiring expertise, time and equipment. This assessment is usually done with methods that require a systematic registration of defects that occur in the various functional elements of the building. The diagnosis of the causes of the defects is not done, but based on the information gathered during the surveys it is possible to lay down intervention strategies and/or conservation and maintenance policies.

In several European countries, including Portugal, different buildings condition assessment methods have been developed, many of which within institutional or legislative initiatives. In these methods the assessment of buildings condition may be used to: determine the value of the property; set taxes, charges or rents; verify habitability conditions; or support decision on rehabilitation, repair or maintenance works.

The purpose of this paper is to compare methods used in European countries to assess the buildings condition. The methods compared were chosen due to their institutional character. Two main research questions are addressed: What are the main differences and similarities of the methods analysed? What recommendations can be drawn to improve the Portuguese method?

The following section briefly describes the assessment methods studied. Section 3 presents the comparative analysis of the methods and in Section 4 some conclusions are drawn.

2 METHODS TO ACCESS BUILDING'S CONDITION

2.1 Portuguese method for building condition assessment

A Portuguese method to assess the condition of buildings (MAEC) was developed within the framework of the Urban Tenancy Regime (Law No. 6/2006) [Portugal 2006a]. This method was approved by Ministerial Decree 1192-B/2006 [Portugal 2006b] and is beng applied since January 2007.

This method sets a maintenance coefficient that is used to calculate the maximum value of the rent of a dwelling unit. Assessment using MAEC is based on the verification of the gravity of the defects that occur in the building elements and equipments and on the condition of the whole dwelling and of the common parts of the building [Pedro *et al.* 2008].

2.2 Housing Health and Safety Rating System

The English method Housing Health and Safety Rating System (HHSRS) [United Kingdom 2004] was created to replace the previous Housing Fitness Standard of the United Kingdom. The HHSRS is being applied since 2000.

The purpose of this system is to evaluate the potential risks to health and safety from the deficiencies identified in dwellings. HHSRS is based on the evaluation of both the likelihood of an occurrence that could cause harm and the probable severity of the outcomes of such an occurrence. The assessment using HHSRS is made based on the condition of the whole dwelling.

2.3 Method for assessment of the condition of buildings that may be declared inhabitable

The French method to assess the condition of buildings that may be declared inhabitable was set by the Health Ministry in the Circular No. 293 (2003-06-23) [France 2003], for renewing the procedure for declaration of unhealthy buildings established in 1971, conducted by the law on solidarity and urban rehabilitation of 13 December 2000 [France 2000].

The purpose of this method is to do a technical assessment of a dwelling habitability conditions and to

gather information about physical degradation of the building. The results support the declaration of inhabitability by the French Hygiene Departmental Council and provide information to guide the works necessary to mitigate the detected defects. The assessment is based on the verification of the gravity of the defects that occur in the building elements and equipments.

2.4 Dutch standard NEN 2767

The Dutch standard for assessment of buildings' condition was published in 2006 (NEN 2767). This standard has three parts: presentation of the method [NEN 2006], list of common defects by gravity [NEN 2008]; calculation formula [NEN 2009].

This assessment method intends to guide the implementation of rigorous and independent technical buildings assessments. The information collected is used to support an objective definition of the condition of each building as well as to plan maintenance interventions, prioritize investments, monitor the progress of building elements degradation and compare the condition of different buildings. The assessment is based on the detection of defects in functional elements, and on the definition of their importance, extent and intensity [Straub 2009].

2.5 EPIQR and TOBUS methods

The EPIQR (Energy Performance Indoor Environmental Quality Retrofit) and TOBUS (Tool for Selecting Office Building Upgrading Solutions) were developed within European research projects. The EPIQR project was completed in 1998 and the TOBUS project was completed in 2000. Specialists from seven European countries worked in the development of these methods (Germany, Denmark, France, Greece, Netherlands, United Kingdom and Switzerland).

The EPIQR project applies to residential buildings and its main objective is to improve energy efficiency and air quality issues, taking into account not only energy consumption and air quality but also the degradation of building elements [Balaras 2000]. The TOBUS project applies to office buildings and was developed to support the refurbishment of buildings to meet the new requirements of energy efficiency, accessibility and facilities [Caccavelli & Gugerlib 2002]. This method used much of the experience acquired with EPIQR but adds new situations and factors applicable to office buildings. These two methods were developed to be applied in the early stages of the rehabilitation/refurbishment design projects. The condition assessment is based on the identification of defects, the definition of the degradation and the extent of the works needed.

3 COMPARATIVE ANALYSIS OF METHODS

The main characteristics of the methods studied are summarized in Table 1. The following paragraphs analyse the results of each feature compared.

3.1 Objective

The methods studied have a wide variety of objectives, such as determine the maintenance condition of dwellings, verify minimum housing conditions and define maintenance plans and repair works.

3.2 Scope

Three of the methods studied apply only to dwellings (HHSRS, French method and EPIQR). The remaining methods may be applied to different types of buildings and their units. The scope of the Dutch method is not an individual unit of the building but the whole building or a building stock.

Table 1. Summary of the assessment methods main characteristics.

	MAEC	*HHSRS*	*INHABITABLE BUILDINGS*	*NEN 2767*	*EPIQR/TOBUS*
Objectives	Determine the condition of the dwelling	Verify minimum housing conditions	Verify minimum habitability conditions	Define maintenance plans and repair works	Define scenarios for rehabilitation and refurbishment
Scope	Rented dwellings and non-residential units	Dwellings	Dwellings	Dwellings and non-residential units	Dwellings (EPIQR) and non-residential units (TOBUS)
Inspection method	Visual inspection	Visual inspection and simple tests	Visual inspection and simple tests	Visual inspection	Visual inspection and simple tests
Attributes assessed	Functional elements and equipments	Functional elements and equipments	Functional elements, equipments and salubrity conditions	Functional elements and equipments	Functional elements and equipments
Disaggregation level	3 main parts; 37 elements	29 hazard categories	3 main parts; 52 elements	4 main parts; 52 elements	50 elements (housing); 72 elements (non-residential)
Weighting coefficients	Based on elements significance	Based on probability of an occurrence that could cause harm	Based on elements significance	Based on repair costs	Based on construction costs
Assessment criteria	Defect gravity (1-5)	Class of harm (I-IV) Likelihood (1-1/5600)	Defect gravity (0-3)	Importance (1-3), intensity (1-3) and extent (1-3) of defects	Degradation level (a-d); Degradation extent (a-d)
Calculation formula	Weighted average	Calculation algorithm	Weighted average	Weighted average	Cost calculation
Results	Defect index and condition rate	Hazard class (A-J)	Unhealthy level	Conservation index	Cost
Surveryors	Civil Engineers, architects and civil technical-engineers	Trained technicians	Trained technicians	Civil Engineers and architects	–
Implementation tools	Checklist; Application instructions illustrated; Internet site	Checklist; PDA software; PC software; Application guidance	Checklist, Application guidance	List of items and defects	Computer software

3.3 Inspection method

In the methods studied, information to assess the buildings and their units is obtained by visual inspection. If the surveyor has to point out the works to repair the defects, some simple tests to look for non visible defects are also planned. These complementary tests usually demand longer surveys.

3.4 Attributes assessed

The attributes assessed are similar in the methods studied. In all methods the construction elements and equipments condition are assessed. The French method also includes the assessment of some safety, health and comfort requirements, as well as the analysis of dimensional design factors. HHSRS also includes the building location or its surroundings.

3.5 Disaggregation level

The disaggregation level of the global assessment is different in the methods studied. The methods that are mandatory and have an extensive application use 30 to 40 attributes (*e.g.*, MAEC, HHSRS). The methods that intend to depict a more accurate analysis and are optional use 50 or more attributes (*e.g.*, Dutch method, EPIQR & TOBUS methods). The French method, although for extensive application, also uses 50 attributes but it also assesses salubrity conditions.

3.6 Weighting coefficients

All methods studied have weighting coefficients that set the importance of each functional element in the final result, but the criteria to set these coefficients is different. The weight coefficients of the MAEC and the French method are based in the contribution of element for the global assessment of the buildings condition. In MAEC structural and building's envelope elements (*e.g.*, external walls, windows and doors) have higher weights and in the French method non-constructive elements (*e.g.*, light, moisture) have higher weights. In the Dutch method and the EPIQR &TOBUS methods the weight coefficients are based on construction costs. In HHSRS the weighting coefficients are based on the probability of an occurrence that could cause harm.

3.7 Assessment criteria

The methods studied use different assessment criteria, but in all of them, except HHSRS, buildings' condition is measured by the defects recorded. In MAEC and the French method the *gravity* of defects is the criteria used. Gravity includes the effects of defects on the functional requirements, the type and extent of the repairs required the relevance of the affected space or facilities to the unit's use, and the existence of alternatives to the affected space or facilities. In the EPIQR &TOBUS methods the *level* and *extent* of defects are used. In the Dutch method *importance*, *intensity* and *extent* of defect are used. In HHSRS the *class of harm* and the *likelihood of accidents* due to defects are used.

3.8 Calculation formula

MAEC, the French and the Dutch methods use calculation formulas based on weighted averages. MAEC also has rules to prevent the attenuation of extreme values. The calculation formula used in HHSRS is different from the others and more complex. This method uses a formula based on the risk of accidents due to existing housing hazards in the dwellings, affecting the most vulnerable age groups of all the users of the space. The definition of values for all the variables involved is a difficult process that requires surveyors with adequate training. The EPIQR &TOBUS methods calculate the cost of rehabilitation.

3.9 Results

The methods studied present different results:

- The French method provides an index calculated independently for each part of the building assessed (common shares and dwelling units);
- MAEC sets a condition index that integrates the assessment of the unit and the common parts;
- HHSRS indicates the degree of risk of accidents due to a certain danger;
- The EPIQR & TOBUS methods determine the rehabilitation cost.

3.10 Surveyors

In the methods studied, the technicians who can conduct surveys need specific training. Only the EPIQR & TOBUS methods do not have this requirement, but these methods are mainly used for academic purposes. The demand for specific training of the surveyors is understood as a key factor in all the methods. The importance of this factor was demonstrated in a previous study carried out in the United Kingdom [Hollis & Bright 1999].

3.10 Implementation tools

Implementation tools were developed for all the methods studied, but the amount and nature of the tools differs. The main tools are the following:

- *Checklist* – All methods studied have a checklist to guide surveyors and record information;
- *Instructions* – All methods have general instructions with examples of common defects, but with different levels of development. The instructions of MAEC and HHSRS have, for each functional element, examples of defects, many of them illustrated. The instructions of the French method also include illustrations of common defects for some functional elements. The Dutch standard presents a list of the most common defects for all functional elements, coded and prioritized, but illustrations have not been included yet, although it acknowledges their importance to help the surveyor;
- *Computer program* – the EPIQR & TOBUS methods and HHSRS, which are particularly complex, have computer programs to support surveyors. These programs record information and calculate results;
- *Website* – MAEC has a website to manage the entire assessment procedure (http://www.portaldahabitacao.pt/).

4 FINAL REMARKS

What are the main differences and similarities of the methods analysed?
The analysis showed that the methods studied have different objectives and scopes. Consequently, they also vary regarding the disaggregation level of the global assessment, the calculation formula used to aggregate partial assessments, the type of the final results obtained and the tools developed for their implementation. However, some similarities among the methods studied were found. In almost all methods the assessment is carried out mainly by visual inspection, the condition of the building is assessed by systematic analysis of the entire building divided into functional elements, the severity of defects is the assessment criterion used, weighting coefficients are used to determine the importance of each partial assessment in the final result and surveyors need specific training.

What recommendation that can be drawn to improve the Portuguese method?
Based upon the results of the comparative analysis, the following recommendations are made for MAEC:

- No changes are required on the inspection method, attributes assessed, disaggregation level, weighting coefficients or calculation formula. The increase in the number of attributes would

increase the time taken for the survey without substantial benefits to the accuracy of the result. Training courses of surveyors are essential to assure a correct application of MAEC.

- In Portugal the owner of a rented unit that has been assessed with MAEC may ask the municipality to define the repair works needed to improve the defect index obtained previously. The information gathered with MAEC is insufficient for this purpose. A second survey would be required using a checklist that identifies the *level* and the *extent* of defects, and conducting simple tests to look for non visible defects. With this information a correct diagnosis of the causes of defects would be possible.
- A computer program to support surveyors during inspections should be developed. This tool should run on a PDA and be able to present the instructions, register answers, record photos and make calculations. Once connected to the Internet, the surveyor could then submit the filled in checklist to the central website.

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