Developing A Structure for Surveying Portuguese Dwellings: Integrating Inspection and Heritage Conservation Theory in Practice (Part I)

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Abstract— The integrated rehabilitation of the historic built environment is a collective responsibility for the public good. However, the scale of the task, the lack of strategy and evidence in many Portuguese municipalities, and administrative barriers to intervention has led to substantial, continued loss of local built heritage. This is further compounded by widespread works undertaken without any permissions, against which local authorities fail to act.

To ease pressure on local authorities and promote citizen engagement, this article proposes a systematic tool suitable for gathering evidence on the state of conservation of the historic environment. “Front loading” the process enables coordinated decisions to be taken, and an evidence-based and pragmatic restoration and regeneration programme to be adopted.

The model emerged from a review of a substantial body of previous studies. It has been extensively piloted and refined, and the results reveal strong potential to provide accurate and detailed results.

Keywords— Building pathology, Heritage conservation, Legal and regulatory compliance, Planning policy and evidence base, Sustainable development.

I. Introduction

According to The World Bank, the world's urban population grew from 34% in 1960 to 55.3% in 2018, with it forecasting that it will increase to 68% by 2050 [1]. In Portugal, 87.4 percent of the population already lives in “urban” or “largely urban” areas [2]. Urban areas are increasingly important sites of encounter, where cultures are formed and reformed through complex interactions. Likewise, they are sites in which a commitment to sustainable development must be put into practice, addressing problems emerging from dispersed and fragmented populations, and the poor spatial interface between populations and services. A commitment to the principles of sustainable development has been made internationally, recently at the Habitat III [3] conference and, at European Union level, in the bloc’s ongoing commitment to spatial planning principles. Sustainable development in the historic environment must involve a reorientation of spatial planning policies to integrate older areas into wider urban and regional development frameworks, considering them part of, rather than separate from, the wider territory.

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The integrated rehabilitation of the historic built environment is a collective responsibility for the common good. For too long, older urban areas have been left to fester, whilst greenfield land in the periphery has been colonized for modern industrial and commercial services, and people have moved out of the older centres to newer ones, leaving older and more vulnerable populations behind [4].

The recent history of its management in Portugal has been one of over-reliance on the public sector, and siloed professional expertise, with disproportionate attention paid to classified monuments to the detriment of the wider historic setting through which these monuments might be understood. The scale of the task, the acute lack of strategy and evidence in many municipalities, and significant barriers to any type of intervention in historic zones has led to substantial, continued loss of local built heritage. This is further compounded by widespread works undertaken without any permissions, against which local authorities fail to act despite the availability of enforcement measures [5].

However, the past few years have seen the emergence of four linked phenomena: 1) growing interest in urban rehabilitation of older areas; 2) desire for user comfort beyond mere stability, 3) a requirement to comply with sustainable development principles (including lifecycle targets and national standards): and 4) increased foreign interest in the Portuguese property market; and there is increasing demand for multi-functional surveying and inspection.

With a view to easing the pressure on local authorities and promoting active citizen engagement, this article proposes a systematic tool that can be used to gather evidence on the state of conservation of the historic environment. This is no substitute for professional competencies, but “front loading” the process in this way enables more effective information gathering and analysis, enabling coordinated decisions to be taken, and a sensitive and pragmatic programme of works to be drawn up based on strong evidence.

The model is applicable to a Portuguese setting, emerging from a review of a substantial body of work from the past two decades. The model has been piloted and refined, and the results reveal strong potential to provide accurate and detailed results, whilst at the same time stimulating local interest, engagement, and responsibility in heritage conservation.

II. Overview Of The Project

At the present time, faced with the requirement to undertake a building inspection to assess its state of conservation, local authorities often rely on a document entitled "Template for the evaluation of the level of conservation of buildings" to undertake reactive assessments when requested on older buildings suffering decay. This template was developed under the auspices of the New Urban Leasehold Regime (NRAU) for the purposes of assessing the condition of rent-controlled properties in a structured yet generic way. It has become a widely used template but is not able to respond to the specifics of a building's condition beyond the state of repair on a quantitative scale of 1-5 (indicating "very serious" to "minor" in terms of severity), of different elements.

The process of the rehabilitation of older buildings requires as multi- and inter-disciplinary an approach as possible [4] [5]. At the same time, and seemingly contrary to such an aspiration becoming a reality, there are time and resource limitations for such collaborative work and, given the sheer number and spatial disparity of older buildings, it is administratively unfeasible to forward-plan for each individual asset. What is required is a transparent management tool which allows an individual professional, or even a team of citizen volunteers or residents under professional supervision, to undertake surveys of older buildings and draw up recommendations not only from the point of view of the identification, diagnosis, and non-structural solutions for rehabilitation, but also taking a more holistic and intertextual view with regard to the building's wider meaning and significance. Such an exercise should also consider contextual factors, including heritage values and significance, and perspectives drawn from other relevant disciplines, to streamline management and decision-making processes in rehabilitation projects.

Whilst, in theory, municipal planning policies and heritage management plans should provide a clear idea to the property owner of what should or should not be done to an older building when planning works, the tool leads with what is and is not possible from a physical (rather than a policy) point of view, taking into consideration the specificities of the individual building as well as the people who use and experience it.

Therefore, the model developed and refined here is timely for the accurate recording of the condition of a building, having the following characteristics:

1. It must be sufficiently technically sound to ensure that it is able to identify and mitigate threats to human safety, alongside other structural, aesthetic, comfort and amenity considerations.
2. It should seek compliance with existing national and local policy and legislation.
3. Critical engagement of the results is needed with regard to heritage principles, to ensure the value and significance of the building or its setting are not compromised by proposed solutions.
4. It should be sufficiently comprehensive yet simple enough for a user to be able to record and trace correlations between anomalies and solutions in a transparent way (to allow for replication).

At its core, this tool aims to encourage the preservation of built heritage as a means of achieving sustainable development. This would achieve the recentralization of people and services to city centres and brownfield sites, demonstrating that older buildings can be converted into comfortable and functional homes without the additional carbon emissions (during construction, lifecycle of mobility requirements) and land take, and ensuring compatible materials so that subsequent generations are able to repair/reverse the existing built environment as opposed to having to demolish and rebuild, following the path of least resistance in the development industry, and thereby aiming to extend useful service life.

III. What Type Of Tool Is Needed?

The inspection of buildings seeks to ensure the safety, maintenance and, as necessary, enhancement of these structures. The process through which this is achieved plays an important part in the final outcome and should always include data capture/collection (elemental), diagnostic (problem), and anticipatory (preventative) components. The focus, however, can vary [6].

A systematic approach to the conservation of masonry walls was developed by Brito [7] and advanced more fully by Gonçalves et al. [8], [9], which outlines a user-friendly series of tasks to be undertaken at 1) inspection; 2) diagnosis, and 3) repair stages, to ensure the comprehensive conservation and enhancement of masonry walls and their claddings.

This builds helpfully on earlier work which undertook a similar exercise for wooden floor structures, as detailed in Delgado & Brito [10], as well as proposals for an overall building condition assessment following equivalent stages of survey and analysis outlined by Brito [11].

The same structured systematic approach has also been developed for a variety of individual architectural items, including for industrial flooring [12]; for the external elements of flat and sloped roofs [7], [13]-[16]; for windows and their openings [17], [18]; internal walls [19]-[24]; architectural concrete elements [25], [26], and External Thermal Insulation Composite Systems (ETICS) [27]. Furthermore, whole building level surveys following the same systematic approach have been proposed, starting with the building envelope (walls, floors, roof and environment) and proposing a future narrowing-down to highlight elements that may not appear in all dwellings [8], [28], [29].

Many of these laudable studies focus only on the correlation between observed anomalies and their diagnosis. The model developed in this paper goes one stage further in establishing the bases for assessing viable means of resolving problems.

Whilst the work undertaken by Gonçalves et al. [8] provides a logical framework for proposing solutions for the repair of anomalies, which in general terms is useful in establishing options, it is wholly blind to the requirements of heritage conservation. For such a model to be useful as a tool for the rehabilitation of the Portuguese historic (urban) environment, it needs to incorporate a further stage that critically analyses the appropriateness of repair solutions in light of conservation principles at an international and national scale.

For the purposes of this study, the proposed model incorporates consideration of some of the mainstream techniques and products applied to older buildings, looking at best practice as espoused by successive heritage charters and crucially, with regard to the ICOMOS [30] principles for the analysis, conservation and structural restoration of the historic environment. The considerations espoused by Goodwin et al. [31] can ensure that the conservation, resolution of pathologies and enhancement of masonry buildings take into account the safeguarding of heritage values and, furthermore, foresee potential negative impacts of well-intentioned interventions.

IV. PRESENTATION OF THE MODEL

An integrated approach to the rehabilitation of the historic environment is the only way of ensuring the wholesale conservation of heritage values and significance, reaching across disciplinary and professional frontiers. A model that integrates the two approaches – a comprehensive exercise in non-structural surveying, diagnosis and proposed repairs balanced with regard to conservation principles - is proposed in a five-stage process as follows:

TABLE I
STAGES OF THE PROPOSED MODEL

1) Background work	Understand the context and important characteristics of the building.
2) Inspection	Visual analysis and identification of anomalies.
3) Diagnosis	Classification of pathologies using "anomaly-probable causes" correlation matrix.
4) Repair Planning	Outline potential repair scenarios, to include: • Preventive rehabilitation techniques (pr) • Remedial rehabilitation techniques (rr) • Maintenance work (m) • Reinforcement techniques (rf)
5) Repair in the context of conserving and enhancing heritage value	Unless unavoidable to ensure the stability and safety of the structure, discount those repair scenarios which do not meet the following criteria: • respect the integrity/character of the building • conserve and/or enhance heritage value • involve minimal intrusion • new works are reversible • are compatible materially, functionally and aesthetically

The five stages are explained here in more detail:

The need for *background work* is crucial for a number of reasons, including environmental, cultural and urbanistic considerations. The primary influence on a building is, naturally, the environment to which it is exposed. This is a rather complex set of intersecting conditions, including water table, runoff, climate, ground conditions, and presence of pollution.

At the *inspection* stage, an in-situ visual analysis of the buildings features is undertaken. A full schedule of anomalies is outlined in more depth in the applied model, but the broad categories are as follows:

TABLE II
TABLE LISTING ANOMALIES (MAIN CATEGORIES)

Anomaly Category Code	Anomaly Category
A-A	Overall performance of the wall
A-B	Coating system
A-C	Current floor surface
A-D	Connections to support (flooring)
A-E	Joints between parts (flooring)
A-F	Floor bio- or chemical deterioration
A-G	Ceiling
A-H	Roof structure
A-I	Roof support connections
A-J	Roof bio- or chemical deterioration
A-K	Sloped roofs// (external)
A-L	Door and window openings
A-M	Flat roofs/ Terraces
A-N	Drainage system

Initially, the inspection is a recording exercise through which any manifestation of those individual anomalies listed in the survey model's table should be recorded irrespective of the scale of the problem.

The *diagnosis* of the origin of anomalies recorded at inspection stage is supported through completion of a matrix that makes a direct link between the anomaly with a list of probable causes. The broad categories within which a more detailed set of building anomalies are listed are as follows:

TABLE III
TABLE LISTING PROBABLE CAUSES (MAIN CATEGORIES)

Probable Cause Category Code	Probable Cause Category
C-A	Project Errors
C-B	Execution Errors
C-C	Environmental/ Biological Action
C-D	Human/ Mechanical Actions
C-E	Maintenance Problems

The correlation matrix traces the anomaly back to its source. It establishes a numerical correlation between the probability of one anomaly being caused by a particular trigger, with a value of "2" applied for a clear correlation, a value of "1" applied for a possible correlation, and a value of "0" or "-" for the absence of a correlation. These matrices do not exempt the surveyor from critical thinking but ensure that a broad range of possibilities is considered in diagnosis.

At the *repair* planning, or solution, stage, the anomaly is traced forwards to the available means of resolving not only the anomaly itself, but ultimately its source. Whilst anomalies may be judged within the model to be structural in nature, this would lead to a recommendation for further investigation by a relevant professional (i.e. civil or structural engineer). Notwithstanding, the non-structural repair solutions in the comprehensive list outlined in the model fall into one of four categories: Preventive rehabilitation techniques (rp); Remedial rehabilitation techniques (rc); Maintenance (m); and Reinforcement techniques (rf).

Preventive rehabilitation techniques (rp) include actions that involve eliminating the cause, though may not treat the anomaly directly. Remedial rehabilitation techniques (rc) include direct repair of the anomaly, either eliminating it, or concealing it and protecting it from the cause. These techniques do not necessarily eliminate the cause. Maintenance (m) includes small scale interventions such as cleaning, ad hoc repair/replacement, and prevention that ideally should be carried out periodically in any case. Finally, Reinforcement techniques (rf) are "improvement" measures to correct inadequacies in respect of the demands of comfort (thermal and acoustic), amenity and cost, rather than referring to technical structural reinforcements or dimensioning. Repair solutions fall into one of the following categories:

TABLE IV
TABLE LISTING POTENTIAL SOLUTIONS (MAIN CATEGORIES)

Repair Category Code	Repair Category
R-A	Masonry Wall
R-B	Wall Coating System
R-C	Wall Final Coating
R-D	Environmental Surroundings
R-E	Wooden Elements (Flooring / Roof)
R-F	Further Surfaces
R-G	Cladding System
R-H	Bearing Structure/ Substrate
R-I	Architectural Detailing
R-J	Window Accessories
R-K	Window Metallic Elements
R-L	Window Frame
R-M	Window Glass
R-N	Adhesive Ceramic Coating (RCA) Surface
R-O	RCA Setting Material
R-P	RCA Joins
R-Q	Concrete Surface
R-R	Concrete Structure
R-S	Concrete Joints/ Discontinuities
R-T	Concrete Peripheral Elements
R-U	Concrete Secondary Elements

A further correlation matrix during this stage cross-correlates the anomaly with individual repair solutions that are, in addressing the anomaly itself, likely to resolve the underlying cause/source.

Finally, in addition to this systematic approach to practical repair, consideration of the heritage value of older buildings, the majority of which have undergone change through time, needs to be added to this process, to ensure that conservation and repair does not erase valuable historical record. A successful act of conservation will ensure that a heritage building is treated with care in order to preserve its historic fabric and maintain its ability to contribute to a nuanced understanding of the past to the greatest extent possible. In the final stage, therefore, those repair strategies and solutions emergent in the previous stage are ranked sequentially in terms of their potential impact on any historic value or significance. Whilst the goal is to resolve anomalies and their causes in the least invasive manner possible, more destructive techniques may be required should the advantages of such intervention outweigh the heritage harm caused.

V. Pilot Applications Of The Model

As Brito et al. [32] note, individual buildings are complex systems, composed as they are of different materials and assemblies which in turn increase uncertainty in terms of planning and performing maintenance. Furthermore, Portuguese urban dwellings are often not easy to understand in terms of their evolution. This is due to the fine urban grain of settlements, added to the fact that internal amplifications have often occurred over the centuries with minimal noticeable impact on the main façade. Whilst terraced dwellings are not limited to Portugal, the hollowing out of a whole terrace for the creation of a single-family home in the same terrace as more humble dwellings, or indeed the reverse process of subdivision, has clear implications for manifestations of certain types of pathologies and their resolution.

This model was piloted recently on four different dwellings, each comprising masonry walls, wooden flooring and roof structures, and ceramic roof tiles, and located in Santarém and Coimbra Districts, in the central part of Portugal.

The most challenging building from a technical perspective recently inspected using the model was such a dwelling, located in Constância. The building had undergone certain ostensibly minor changes over time, but these have had a disproportionately significant effect on the manifestation of anomalies. Likewise, this four-storey terraced dwelling used to be a dependency of the neighbouring manor house, but the survey house (and not its garden) was severed from the ownership in the late twentieth century. This administrative act has meant that no access or works have been possible to the rear façade for the past 30 years, whilst regulations on residential amenity have disallowed opening windows on the rear façade leaving openings only on the front [33]. This, combined with the installation of sealed double glazing, and water ingress from the rear façade, contributes to high relative humidity and therefore the rotting of wooden elements and the phenomenon of rising damp at lower levels. To this end, it is crucial to understand the context and changes over time of a building as part of an inspection to diagnose any current pathologies and to therefore be able to develop a sound, evidence-based solution for intervention. This was a particularly noteworthy, but not unusual, case in which the urban context of the dwelling (beyond building environment considerations) explains its manifesting anomalies.

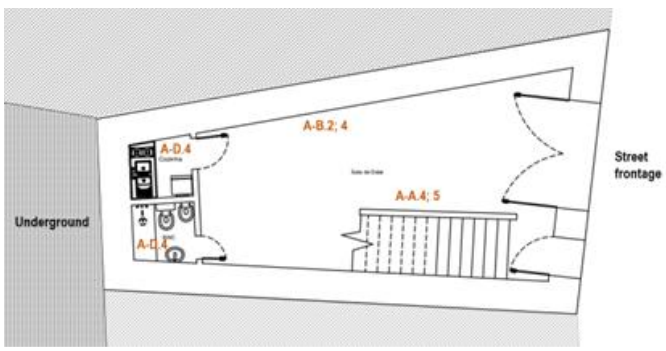

Fig. 1 Plan of the ground floor of the dwelling inspected in Constância. It is bounded on two sides by other habitations, and at the rear far beneath the rear neighbour's patio, leaving a single façade.

Fig. 2 Manifestations of pathologies in part due to inadequate ventilation, and other causes identified through the model.

Reflecting on the model, early results revealed that the methodology, albeit reasonably efficient in identifying and diagnosing core problems with the dwellings, lacked sufficient detail and nuance to enable it to address more modern constructive elements that had been added to the core house over time. An iterative process of review following each subsequent application of the methodology meant that it could eventually provide an accurate and transparent means for non-professionals (albeit under professional supervision) to establish the state of conservation of an older building and provisionally plan for its rehabilitation/renovation.

The model has undergone further piloting over the past year and has informed the project plans for the intervention strategy for several of the buildings inspected.

VI. Conclusion

There is a demonstrable need to improve the evidence gathering approach regarding the state of conservation of the historic built environment in Portuguese cities. This is imperative in light of multiple intersecting challenges and opportunities presented by current economic and social conditions, and at the same time fulfilling national and international environmental and sustainability requirements.

The model developed and presented in this article has been trialled with success in a Portuguese setting, and is firmly anchored in theory, having emerged from a review of a substantial body of work from the past two decades. The model has been extensively piloted and refined, and the results reveal strong potential to provide accurate and detailed results, whilst at the same time stimulating local interest, engagement, and responsibility in heritage conservation.

Whilst the model, as piloted, provides a transparent and replicable means of presenting the data, it requires further refinement to make more intuitive and user friendly lest it alienate a section of the very professionals it is intended to serve. The "problem" was the sheer quantity of solutions, with 147 categories – this is exhaustive yet overwhelming, not only on a conceptual level, but also on a practical level.

Likewise, a clear limitation to the model is its assumption that similar or compatible materials have been used in any alterations or extensions to the dwelling over the years. This is seldom the case, and the vast majority of dwellings evaluated using this model have suffered at least some substitutions of original elements with reinforced concrete. More refinement is therefore required to analyse and identify commonly substituted elements and the ways in which these were installed. This would enable a more fundamental decision to be made, namely the impact of alterations on the original structure and whether these alterations can/should be reversed or retained.

The current demand for property in Portugal is unprecedented, and construction in the country is booming [34]. There is, finally, a marked increase in interest in restoring and enhancing older buildings for habitation which must be capitalized upon to ensure our heritage survives for the next generation. However, with so many municipalities lacking a clear evidence base to inform decision-making during renovations, or for taking enforcement action, there is a clear threat to a large swathe of our built heritage.

This model represents a clear advance in enabling the structured evaluation of heritage assets with the potential to be used by a broader number of people, informing transparent decision-making in conservation and renovation projects.

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