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«Values Evaluation Method» to assist in the decision-making process for intervention on architectural heritage

«Método de Evaluación de Valores» para facilitar el proceso de toma de decisiones para la intervención en el patrimonio arquitectónico

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ABSTRACT

A method of analysis of heritage values (VEM - Values Evaluation Method) as criteria for intervention in existing buildings is presented. It is based on the authenticity of the values and on the integrity and functionality of the building. A matrix of values has been prepared that allows their parameterization and weighting, as well as the proposal of possible interventions for their recovery. Here we carry out the application of the method to a series of interventions already made to verify the effectiveness of the method. Eleven cases of buildings in two countries (Algeria and Spain) have been selected, on which there are previous studies and total or partial interventions. The buildings are briefly presented and the application of the method to these buildings is compared with the actual interventions. The great similarity between them allows us to confirm the effectiveness of the VEM as a tool for decision-making prior to the intervention.

Keywords: Architectural intervention; decision-making process; building recovery; value assessment; value parametrization.

RESUMEN

Presentamos un método de análisis de valores patrimoniales (VEM –Values Evaluation Method) como criterio para la intervención en edificios existentes. Se basa en la autenticidad de los valores y en la integridad y funcionalidad del edificio. Se ha confeccionado una matriz de valores que permite su parametrización y ponderación, así como la propuesta de posibles intervenciones para su recuperación. En este artículo llevamos a cabo la aplicación del método a una serie de intervenciones ya realizadas para comprobar la eficacia del método. Se han seleccionado 11 casos de edificaciones en dos países (Argelia y España), sobre los que existen estudios previos e intervenciones totales o parciales. Se presentan sucintamente los edificios y se comparan las aplicaciones del método a los mismos con las intervenciones reales. La gran similitud entre ambas nos permite confirmar la eficacia del VEM como herramienta para la toma de decisiones previas a la intervención.

Palabras clave: *Intervención arquitectónica; toma de decisiones; recuperación de edificios; evaluación del valor; parametrización del valor.*

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1. INTRODUCTION

Change within the historical environment is an inevitable phenomenon shaped by natural processes, deterioration, and societal responses to various stimuli (1). The realm of culture is increasingly focusing on heritage and its historical environment, both on a global and local scale. The recovery of heritage bears profound and lasting economical, societal and environmental impact. To comprehend this scenario, our analysis delves into a chronological and critical examination of existing discussions on heritage values and intervention decisions. This comprehensive study encompasses international charters, recommendations, national heritage laws, standards, and scientific research from the early 19th century onwards, culminating in the creation of a taxonomy of pivotal values and intervention actions (2). This taxonomy serves as a model, providing essential criteria for decision-making preceding interventions.

Conservation involves managing change in a significant place to sustain its heritage values while recognizing opportunities to reveal or reinforce those values for present and future generations (1). It is noteworthy that intervention theories have evolved from pure restoration, known as 'conservation 1.0,' to a more integrated approach, conservation 3.0 (3), which emphasizes tangible and intangible attributes with values (4, 5). The intervention scales, ranging from maintenance to rehabilitation, each address specific values (6).

Since the 19th century, and in response to perceived shortcomings in intervention practices on the built environment, international and national recommendations have advocated for the protection and improvement of heritage values. The Faro Convention (7) encourages actions based on the recognition of values for preserving cultural heritage. However, despite heritage recovery being a crucial 21st-century challenge, the absence of an adequate, objective, and comprehensive method for optimal recovery hinders intervention decisions. Taking appropriate measures to recover heritage values is imperative for preventing further degradation and should be an integral part of a long-term strategy to reduce vulnerability and ensure protection. Between the recognized progressive and cultural approaches (8), we propose a median approach to recover neglected elements. Our method allows for qualitative and quantitative assessment of values, leading to the identification of necessary intervention actions. The established values evaluation method (VEM) provides an effective and objective tool for decision-making, supported by a model value sheet.

The VEM aids in determining whether to intervene, how to intervene, and which actions to prioritize. This modern axiology is based on a dynamic system (9), facilitating the decision-making process without the need for extensive prior consultation. Buildings and places, viewed as documents, physical objects, and living spaces, encompass historical, artistic, contextual, technical, integrity, and functional values (2, 6, 10).

In this article, we aim to showcase the effectiveness of the VEM method. Exploring the process of parameterization and normalization, we apply the VEM to real cases, comparing results with real-world interventions in subsequent sections.

2. RESEARCH AIM

The aim of this article is to explain and justify the Value Evaluation Method (VEM). For this, a taxonomic file of values and interventions has been elaborated first. Then, a new file has been done as an objective tool for making intervention decisions, estimating the values both qualitatively and quantitatively and determining whether to intervene or not, how to intervene and what actions should be prioritized.

First, the evaluation form is presented in detail in several phases due to its length. Its parameterization is explained, indicating the allocation of quantities and its normalization by values. Secondly, matrices 1 and 2 are presented, which help us to interpret the results obtained from the parameterization of the values and allow us to determine the option to intervene, as well as the different actions recommended for it in each case. Third, the VEM is applied to a series of real cases, specifically 11 buildings with real interventions, in order to verify its usefulness and effectiveness. As a conclusion, a comparison is made between the actions carried out in the cases studied and those obtained with the method. In addition, a multicriteria decision making (MCDM) methodology was applied to confirm the effectiveness of the method.

3.THE HERITAGE INTERVENTIONS: AN OVERVIEW OF VALUES AND APPROACHES

In the 21st century, concerns about commercialization may introduce limitations to established conservation principles (11). On the other hand, the concept of "value" encompasses numerous dimensions (artistic, symbolic, historical, social, economic, scientific, educational, technological and functional) that are subject to evaluation, context and opportunity (12, 13).

Since the Venice Charter of 1964 (14), the perception of heritage and its conservation has evolved, emphasizing cultural significance (15). Values-based decision making now requires a systematic analysis of international documents promoted by the Council of Europe, UNESCO and ICOMOS (16). Interventions guided by value criteria aim to safeguard heritage assets and improve their performance. This substantiates the central role of values as a decision criterion.

A thorough examination of intervention theories and concepts, tracing their origins to the present day, underscores the pivotal role of values as a critical decision criterion in the field. The chronological exploration covers 19th-century classical heritage intervention theories, which introduced a dichotomy between Stylistic Restoration and Historical Restoration, each offering distinct approaches to either restoring aesthetic or historical values (17-19). The early 20th century witnessed the emergence of Restoration-Conservation culture, leading to Modern Conservation and Modern Restoration, with a focus on recovering time-related values and preserving authenticity.

The second half of the 20th century saw the rise of modern intervention theories, such as Critical Restoration (20), which aimed to recover aesthetic-historical values through reversible methods. International charters formalized key theoretical concepts, emphasizing modern and scientific restoration (21). The late 20th to early 21st century marked the integration

of additional modern theories, shifting from restoring aesthetic values to rehabilitating cultural and functional values (22). The postmodern period prioritized conservation and management over restoration (23, 24). From the 2000s, conservation evolved towards a sustainable approach, emphasizing minimal and reversible intervention in alignment with project sustainability and ownership reaffirmation (25-28).

On the other hand, the contemporary specialists highlight the importance of consolidating a unified intervention to maximize the value of a building (6, 29-35). Broadly speaking, we can consider three simultaneous actions in an intervention: *Restoration* of historical-artistic values, *Rehabilitation* of functional values and *Repair* of technical values. At the same time, we must consider the recovery of physical, social and economic *contextual values*. Furthermore, any intervention that conflicts with heritage values is considered unacceptable under heritage laws (36-38).

Finally, the conservation literature highlights the need for both qualitative (2, 5, 39) and quantitative (40-44) estimation of heritage values and periodic international reviews are recommended to refine value-based criteria (42, 45, 46). As Joseph E. S TIGLITZ rightly pointed out, what we measure decides what we do.

In conclusion, the integration of qualitative and quantitative approaches, supported by decision-making tools, is crucial for effective quantification of value and for ensuring the sustainability of heritage interventions (47).

4. EVALUATION FORM

The developed model sheet serves as a comprehensive criterion for making objective and precise intervention decisions by estimating values outlined in the earlier taxonomy, while also providing a classification of values and intervention actions. In this section, we elucidate these aspects through two primary phases:

- Content Explanation (Parameterization and Weights)
- Description of the Decision Matrices

The subsequent sections will delve into the final two phases:

- Application to Real Cases
- Results Comparison

4.1. Parameterization of the values

The model sheet is structured with a list of values (history, venustas, firmitas, utilitas, and context) in column C.1, corresponding subvalues in column C.2, and evaluation parameters for each subvalue in column C.3. These parameters relate to justification indices, encompassing all aspects of qualitative evaluation discussed in the upcoming tables (columns 4 to 7). Table 1 provides a summarized overview of the model sheet content, which will be further expounded upon.

The parameterization of each subvalue involves identifying its defining aspects, detailed in column C.3. Quantitative justification indices, reflecting the significance of each parameter and subvalue, are summarized in column C.4. Normalizing these quantities (in column C.5) facilitates inter-comparison, utilizing partially the SAATY reference method (48), which scales subvalues between 0 and 1, with a maximum of 10. Weights are then assigned in column C.6, ranging from 1 to 3, according to the decision maker considerations (9, 49).

The final result in column C.7 summarizes the normalized and weighted subvalue parameterization. This result informs preferences and helps in prioritizing actions in the event that intervention is decided. As each subvalue's maximum weight is 3, the total sum of normalized and weighted subvalues reaches a maximum of 30. These statistical operations collectively yield values crucial for making objective decisions.

Subsequent tables (2.a, 2.b, 2.c, 2.d) present the parameterization data and justifications for the considered values in column C.1. After the tables, some clarifications are included on the meaning of the values and subvalues to better understand the questions that allow their assessment.

Technical Value refers to the material aspects of the building, including the technological characteristics and the technical innovation of systems and materials.

Integrity Value reflects the state of stability and conservation of the building, considering the pathological processes that affect it (physical, chemical, mechanical and anthropological damages). For this, a technical inspection is necessary, assessing its stability and degree of conservation, with direct observation of the damage to the building and the degradation of the materials (art. 2.5) (50), using a complete table of injuries (51), and analyzing compliance with both original and contemporary technical standards.

Table 1. Summary chart of heritage value assessment model sheet. *Source: Authors, 2022*

C.1	C.2	C.3		C.4	C.5	C.6	C.7
Values	**Sub-Values**	**Evaluation parameters for sub-values**		**Parameterization of sub-values**	**Normalization of sub-value parameterization**	**Weighting of Normalized values; Assignment of Weights**	**Final result; Normalized and weighted parameterization for sub-values**
	Qualitative estimation			*Quantitative estimation*			
History Venustas Firmitas Utilitas Contextual				Σ=[0–45]	Σ=[0–10]	[1-3] : for each value	Σ=[0–30]
Any other valid value (ecological, time…or other): case by case							
Decision-making to intervene or not: Matrix-1							
Decision-making on how to intervene: Matrix-2							

Table 2.a. Model sheet of heritage value assessment; chart of historical-artistic values. *Source: Authors, 2022*

C.1	C.2	C.3			C.4	C.5	C.6	C.7
Historic	Historical associations	Thematic	Historical typology(ies) Does the building illustrate a significant or noteworthy theme in the history of the country?	Yes (1)/No (0)	*From 0 to 7*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
			Evolution and particularity of local history: Does the building hold a unique and significant historical significance? Does it depict a crucial phase in the community's evolution or a noteworthy change or turning point in its history?	Yes (1)/No (0)				
		Important event(s)	Are there any notable and significant events directly linked to the building or place?	No event (0) One event (1) Several events (2)				
		Important person(s)	Are there one or more important people directly associated with the building/place?	No person (0) One person (1) Several persons (2)				
		Important designer(s)	Does the building illustrate the work of an noteworthy designer?	Yes (1)/No (0)				
Venustas	Formal aesthetics	Architectural style(s)	Does the building illustrate one or more important or significant architectural styles that characterize the periods in which it was constructed or modified?	Yes (1)/No (0)	*From 0 to 3*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
		Meaningful formal composition	Does the building exhibit a formal aesthetic quality consistent with its architectural type or style?	Yes (1)/No (0)				
		Artistic and archi-tectectonic details	Does the building feature exceptional artistic and/ or architectural details of significance?	Yes (1)/No (0)				
	Space aesthetics	Spatial composition	Does the building exhibit a functional aesthetic quality in its interior spaces?	Yes (1)/No (0)	*From 0 to 1*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*

Table 2.b. Model sheet of heritage value assessment; chart of technical and integrity values. *Source: Authors, 2022*

C.1	C.2	C.3			C.4	C.5	C.6	C.7
Firmitas	Technical value	Building systems (Foundations, structure, facades, roofing, exterior and interior finishes, interior distribution system)	Does the building demonstrate a visual technical constructional quality, considering the efficiency in selecting materials, adopting constructive/technological solutions, layout, and construction methods, in alignment with contemporary techniques and functional types?	Yes (1)/No (0)	*From 0 to 5*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
			Do the building's construction systems have a visual technical quality in relation to the behaviour and performance of the building?	Yes (1)/No (0)				
		Constructive/ decorative details	Does the building have a visual technical construction quality in its details?	Yes (1)/No (0)				
		Installations	Does the building exhibit visual technical construction quality in its installations, including illumination, ventilation, heating (chimney, air-conditioning), vertical transportation, security, and piping (water and sewage networks) – all contributing to the proper functioning of the building?	Yes (1)/No (0)				

C.1	C.2	C.3				C.4	C.5	C.6	C.7
Firmitas	Technical value	Execution and use of building materials		Does the building have a visual technical constructional quality in terms of the execution, use of materials and implementation of the construction?	Yes (1)No (0)				
	Integrity value	Of structure	Foundations	Do the foundations illustrate a high level of technical integrity?	Yes (1)/No (0)	*From 0 to 7*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
			Superstructure	Does the structure exhibit a degree of technical integrity, encompassing both partial and complete stability?	No stability (0) Partial stability (1) Complete stability (2)				
		Facades (envelope)		Does the façade demonstrate a high level of technical integrity?	Yes (1)/No (0)				
		Covers/decks		Do the roofs and/or terraces illustrate a high level of technical integrity?	Yes (1)/No (0)				
		The interior distribution system (Walls, finishings, doors, carpentry, lift, stairwell, courtyard, vestibule...)		Does the internal distribution system and finishes demonstrate a high level of technical integrity?	Yes (1)/No (0)				
		Installations		If the building has facilities, do they exhibit a high level of technical integrity?	Yes (1)/No (0)				

Table 2.c. Model sheet of heritage value assessment; chart of values of habitability and adaptability. *Source: Authors, 2022*

C.1	C.2	C.3			C.4	C.5	C.6	C.7
Utilitas	Habitability value	Type of occupation/use	Does the building demonstrate functional quality through its intended use and the nature of its chronological occupation?	Yes (1)/ No (0)	*From 0 to 4*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
		The current relevance of this function	Is the building currently characterized by a substantial level of habitability based on its spatial characteristics, including program, surfaces, hierarchy, and spatial distribution?	Yes (1)/ No (0)				
			Does the building currently exhibit a high level of habitability with regard to universal accessibility, particularly for individuals with reduced mobility?	Yes (1)/ No (0)				
			Does the building currently demonstrate a high level of habitability in terms of its provision of essential facilities, such as ventilation and lighting conditions, as well as comfort facilities, including mobility, security, insulation, fire/ earthquake resistance, and a satisfactory thermal, acoustic, and visual environment?	Yes (1)/ No (0)				
	Adaptability value	Adaptability of the building to a new use	Can the building easily undergo a change in use, considering both functional and legal appropriateness conditions?	Easy (1)/ Difficult (0)	*From 0 to 3*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
			Does it have the possibility of easy adaptation to universal accessibility regulations?	Yes (1)/ No (0)				
			Does the building hold potential for improvement and adjustment to align with comfort facility regulations, taking into account both functional and legal appropriateness conditions?	Yes (1)/ No (0)				

Table 2.d. Model sheet of heritage value assessment; chart of contextual values (of site, social, economic). *Source: Authors, 2022*

C.1	C.2	C.3				C.4	C.5	C.6	C.7
Contextual value	Site value	Location and elements of nature		Is the quality of the physical visual context important for the building?	Yes (1)/No (0)	*From 0 to 5*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
				Has the quality of the historical/ landscape link between the building and its physical context (environment) been well maintained?	Yes (1)/No (0)				
		Building and urban/rural setting		Is the quality and significance of the relationship between the building and its built environment important?	Yes (1)/No (0)				
				Does the building contribute positively to the current character of the urban/rural area in which it is situated?	Yes (1)/No (0)				
		Existing facilities around the building		Does the design of the development contribute to enhancing its context, including atmosphere, views, and integration?	Yes (1)/No (0)				
	Socio Anthropological value	Ethno-anthropological origin		Does the building express a significant authenticity and uniqueness?	Yes (1)/No (0)	*From 0 to 6*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
		Current social and spiritual identity		Cultural (symbolic) recognition: Are the historic-artistic values of the building recognized by the community, including awareness among the general public, users, and neighbors?	Yes (1)/No (0)				
				Social recognition (of memory/ contemporaneity; Spirit/Memory of place): Is the social use of the building recognized and dedicated to the users of the time, fostering social interaction with the building?	Yes (1)/No (0)				
		Enhanced current social focus		Legal Recognition: Is there official political legislation and/or administrative norms established by the ministry, region, or municipality for the protection of the building or a complex?	Without protection(0) Basic protection(1) Medium protection(2) Completprotection(3)				
	Economic value	Before Intervention	Value of the property now	Is it economically viable to intervene taking into account the current physical qualities of the property, its cost and possible urban speculation?	Yes (1)/No (0)	*From 0 to 4*	*[0–1]*	*[1–3]*	*[0–1] x [1–3]*
			Economic value of the building	Does the economic return cost significantly contribute as a value generated by the asset, considering the impact of its socio-cultural management costs?	Yes (1)/No (0)				
		In the case of intervention, estimating the anticipated cost of the decision-making process		How does the significance of the intervention cost vary based on the building's condition, considering factors such as structural stability, value recovery, improvement in conservation, and adaptability to comfort conditions?	Expensive (0)/ Not expensive (1)				
		Anticipated maintenance costs post-intervention		How crucial is maintenance for ensuring the property's sustainability?	Very expensive (0)/ Not expensive (1)				

Habitability Value: Assessment of the degree of habitability, use and functionality of the spaces and the complex.

Adaptability Value: Consideration of other use options for future modifications, in general.

Site Value: Value of the physical context, including the historical and/or scenic importance of the environment.

Socioanthropological Value: Examination of the social and anthropological context, along with social interest in the environment.

The *levels of legal protection* are classified as follows:

0- No protection
1- Basic Protection (PGOUM (52) Level 3 or equivalent)
2- Medium Protection (PGOUM Level 2; registered in the inventory according to Algerian heritage law or equivalent)
3 - Full protection (PGOUM Level 1; BIP (53); BIC (37); classified as a national monument, or creation in safeguarded sectors, according to the Algerian Heritage Law 98/04 (36) or equivalent)
(BIP: Asset of Heritage Interest, according to law 3/2013, of June 18, of the historical heritage of the Community of Madrid. BIC: Asset of Cultural Interest, according to law 16/1985, of June 25, of the Spanish Historical Heritage.)

4.2. Decision matrices

After quantifying the values, the intervention decision is obtained through two successive and interdependent steps: Matrix 1 and Matrix 2 (Table 3). Matrix 1 is employed to determine the necessity of an intervention based on the estimated values, categorizing different intervention possibilities. It consolidates the data into three categories: interest, necessity, and feasibility of the intervention.

-The *interest* is influenced by various values, including historical, artistic (formal and spatial aesthetic), technical functional (habitability), contextual (physical site and socio-anthropological) values, normalized, weighted, and parameterized, resulting from Column C.7, ranging between 0 and 21.

If there is significant interest, an intervention is recommended. It can be *high* (equal to or greater than 11), *medium* (between 7 and 11), or *low* (less than 7).

-The *necessity* to intervene is directly linked to integrity values. It is derived from Column C.7 and ranges between 0

Table 3. Model sheet of heritage value assessment; matrix-1 and matrix-2 of decision. *Source: Authors, 2022*

<table>
<tr><th colspan="10">Decision-making to intervene or not: Matrix-1</th></tr>
<tr><th colspan="2" rowspan="2">Opportunities for intervention</th><th rowspan="2">Interest= [0-21]</th><th rowspan="2">No Need = [0-3]</th><th rowspan="2">Feasibility = [0-9]</th><th colspan="5">Result-1</th></tr>
<tr><th colspan="3">Proposed Decision; by Decision Maker-1:</th><th colspan="2">Real Decision; Actions taken by other Decision-Makers</th></tr>
<tr><td colspan="2">Possibility 1</td><td rowspan="2">Very high</td><td>Minor necessity</td><td></td><td colspan="3">Maintain only</td><td colspan="2"></td></tr>
<tr><td colspan="2">Possibility 2</td><td rowspan="5">Major necessity</td><td>High feasability</td><td colspan="3">Complete intervention</td><td colspan="2"></td></tr>
<tr><td colspan="2" rowspan="2">Possibility 3</td><td>Low feasability</td><td colspan="3" rowspan="2">Intervene by priorities</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Moderate</td><td>High feasability</td><td colspan="2"></td></tr>
<tr><td colspan="2" rowspan="2">Possibility 4</td><td>Low feasability</td><td colspan="3" rowspan="2">Intervene partially</td><td colspan="2"></td></tr>
<tr><td>Low</td><td>High feasability</td><td colspan="2"></td></tr>
<tr><td colspan="2">Possibility 5</td><td>Low feasability</td><td colspan="3">Not to intervene</td><td colspan="2"></td></tr>
<tr><th colspan="10">Decision-making on how to intervene: Matrix-2</th></tr>
<tr><th colspan="4" rowspan="2"></th><th colspan="4">Proposed Decision; by Decision Maker-1:</th><th colspan="2">Real Decision; Actions taken by other Decision-Makers</th></tr>
<tr><th colspan="4">Actions</th><th colspan="2">Building elements</th><th>Very necessary</th><th>Necessary</th><th>Less necessary</th><th>Not necessary</th><th>Yes</th><th>No</th></tr>
<tr><td colspan="4">Maintenance</td><td colspan="2">General</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="14">Degrees of interventio</td><td rowspan="2">Consolidation</td><td rowspan="2">Structure</td><td>Foundations</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Superstructure</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Repair</td><td colspan="2">Façade(s)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Roof(s)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Internal distribution and finishings</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Installation(s) (Repairing the existing)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Rehabilitation</td><td colspan="2">Adaptability; changing use</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Habitability: Maintaining use and improving...</td><td>Comfort facility (ies) (Retrofit or renovation)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Universal accessibility</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Access and layout physical context</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Restoration</td><td colspan="2">Architectural details</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Formal aesthetics</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Spatial aesthetics</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

and 3, indicating either a *minor* need (greater than 2.5) or a *major* need (less than 2.5).

-The *feasibility* of interventions relies on integrity, adaptability, and economy, as a sum of them, normalized, weighted, and parameterized. It results from Column C.7, ranging between 0 and 9, indicating either *high* feasibility (greater than 4) or *low* feasibility (less than 4).

The decision to intervene hinges on the preservation of values and the extent to which they require intervention. The matrix provides five options: Maintenance only, complete intervention, intervention by priorities, partial intervention, no intervention. If intervention is deemed necessary, Matrix 2 is utilized to determine how to intervene. Taxonomy of actions is provided with five variants (*maintenance, consolidation, repair, rehabilitation, and restoration*). Additionally, four alternatives are presented for prioritizing each action based on the importance of the parameter in column C.3 (*very necessary, necessary, little necessary, not necessary*). Very necessary implies much needed, urgent, and entire. A lower value indicates a greater need.

Actions on Building Elements encompass interventions that define evaluation parameters. The result culminates in the proposed decision by Decision Maker-1. The levels of importance for each intervention action hinge on the degree of integrity of the elements. The levels of interventions are as follows:

- *Maintenance*
- *Consolidation* (Low parameter integrity 1, 2 of C.3)
- *Repair* (Low parameter integrity 3, 4, 5, 6 of C.3)
- *Rehabilitation* (to improve habitability or readapting)
- Restoration (Low integrity of architectural details of parameters 2, 3, 4, 5 of C.3 and recovery of Venustas).

5. APPLICATION TO REAL CASES

The decision-making process, based on criteria values, is facilitated by the outcome obtained through the application of the Value Evaluation Method (VEM). The proposed method underwent testing on a selection of real cases, aiming to validate its reliability and assess its practicality and effectiveness. A total of eleven [11] architectural heritage cases were considered, spanning diverse geographical and social contexts in Algeria and Spain. These cases represent a spectrum of typologies, including entire buildings, building components (facades, courtyards, etc.), and groups of buildings (urban complexes, homogeneous organic fabric, etc.). They also encompass various historical periods (ancient, medieval, and modern) and serve different functions (religious, cultural, residential, administrative, commercial, etc.). This diverse array of cases enables us to establish the objectivity of the study and affirm the applicability and reliability of our method across various scenarios (Figures 1 and 2).

The method has been applied to all eleven cases, but for the sake of simplicity in this article, and as a representative sample of our work, we present the results of the intervention decisions (Matrix 2) for two specific cases—one in Spain and the other in Algeria. The first case involves a 12th-century church in the province of Zaragoza, Spain, where a comprehensive consolidation was undertaken without progressing to restoration or rehabilitation. The second case pertains to Algerian commercial galleries in Algiers, where a complete intervention, encompassing repair, restoration, and rehabilitation, was executed. Tables 4 and 5 showcase the intervention matrices for each case, featuring a column detailing the actual actions taken, allowing for a direct comparison of the results. Additionally, Figures 3 and 4 present graphs illustrating the percentages of various proposed intervention actions in each case, contrasting them with the actions implemented in reality.

XII century church in the province of Zaragoza

Facades of an old administrative building in Madrid

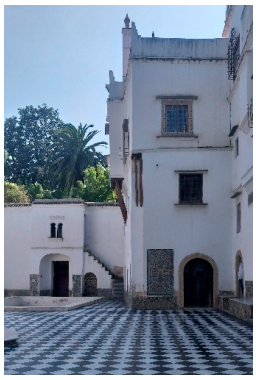
Episcopal Palace in the province of Zaragoza

Patio of the Episcopal Palace in the province of Zaragoza

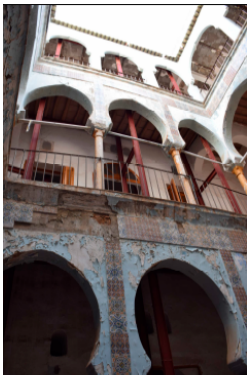
Residential building in Madrid XIX century

Figure 1. Spanish cases

Algerian commercial galleries

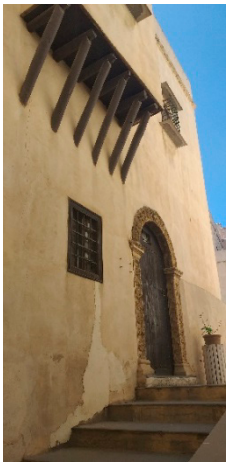


Museum of Algiers



House and adjoining houses, Kasbah of Algiers

Bastion in Algiers



Palace in the Bastion of Algiers

Apartment buildings in Algiers

Figure 2. Algerian cases

Table 4. Intervention decisions on the Church in the province of Zaragoza. *Source: Authors, 2022*

Decision-making on how to intervene: Matrix-2 (Taxonomy actions)														
			Proposed decision by Decision Maker-1:										**Real Decision:** *Actions taken by other Decision-Makers*	
Actions	**Building elements**		**Very necessary**		**Necessary**		**Less necessary**		**Not necessary**				**Yes**	**No**
Maintenance	General								×	0				×
Consolidation	Structure	Foundations	×	1									×	
		Superstructure	×	1									×	
Repair	Facade(s)				×	0,8							×	
	Roof(s)		×	1									×	
	Domestic distribution		× finishes	1										×
	Installation(s)								×	0				×
Rehabilitation	Adaptability				×	0,8								×
	Habitability	Comfort installation(s)			×	0,8								×
		Universal accessibility			×	0,8								×
		Access and accommodation physical context			×	0,8								×
Restoration	Architectural details		×	1										×
	Formal aesthetic		×	1										×
	Spatialaesthetics				×	0,8								×

Table 5. Intervention decisions on the Algerian commercial galleries. *Source:Authors, 2022*

Decision-making on how to intervene: Matrix-2 (Taxonomy actions)														
			Proposed decision by Decision Maker-1:										**Real Decision:** *Actions taken by other Decision-Makers*	
Actions	**Buildingelements**		**Very Necessary**		**Necessary**		**Less necessary**		**Not necessary**				**Yes**	**No**
Maintenance	General								×					×
Consolidation	Structure	Foundations							×	0				×
		Superstructure	×	1									×	
Repair	Facade(s)						× Good integrity	0,6	×					× Ravalment / face lift
	Roof(s)		×	1									×	
	Domestic distribution		× Only elements that will be maintained when changing usage	1									×	
	Installation(s)								× renovate	0				×
Rehabilitation	Adaptability				× possibility of keeping the same use	0,8							×	
	Habitability	Comfort Installation(s)	×	1									×	
		Universal accessibility	×	1									× partially Repair only Existing-elevators 0,5	
		Access and accommodation physical context			× partial Vehicle access and parking	0,8								
Restauration	Architectural details		×	1									×	
	Formal aesthetics				×	0,8							× Partial	
	Formal aesthetics				×	0,8							× Partial	

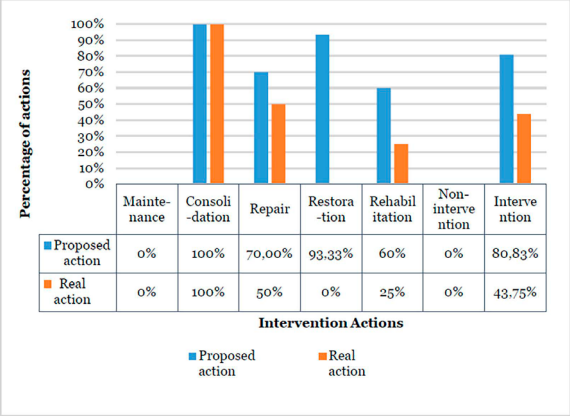
Table 6 provides a comprehensive summary of the outcomes derived from the application of the VEM method to the 11 cases. It encompasses the typology of each building, the parameterization of their subvalues, and the results obtained concerning their interventions. Notably, the parameterization is calculated by summing all normalized and weighted subvalues, capped at a maximum of 30 for each case, denoted as 'Σ= [0–30]: (C.7)'. The last two columns present the results from applying the VEM method (Matrix 1) and the actual interventions undertaken in each case, allowing for easy comparison. It is important to note that the results of Matrix 1 hinge on the combination of values related to interest, necessity, and feasibility.

The intervention proposals generated through the application of VEM in the eleven cases exhibit a notable alignment with the actual actions implemented. This alignment underscores the reliability of the VEM as a decision-making method for heritage interventions. The findings suggest that VEM holds promise for enhancing the conservation and management of cultural heritage, thus ensuring its sustained preservation for the benefit of future generations.

6. RESULTS: ANALYSIS AND DISCUSSION

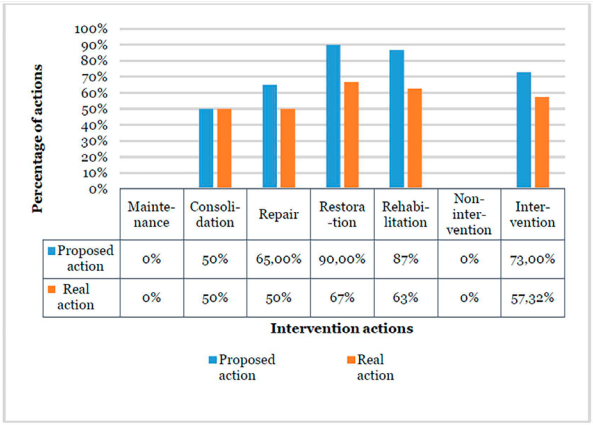
Based on the findings presented in the tables and graphs, the following analysis can be conducted. Before carrying it out, it is worth remembering that, unlike T. Saaty's multi-criteria decision-making method, which requires a group decision (41, 42), our approach is based on the estimation of values by a single expert in decision making, given that the VEM sheet encompasses all the parameters from the points of view of the different agents.

In the first case (Figure 3), the coincidence percentages suggest a partial alignment between reality and the VEM proposal. The suggested intervention for the XII century church was 80.83% (comprising 25% consolidation, 17.5% repair, 23.33% restoration, and 15% rehabilitation), while the executed intervention was 43.75% (with 25% consolidation,



	Maintenance	Consolidation	Repair	Restoration	Rehabilitation	Non-intervention	Intervention
Proposed action	0%	100%	70,00%	93,33%	60%	0%	80,83%
Real action	0%	100%	50%	0%	25%	0%	43,75%

Figure 3. Graph of the coincidence percentages / differences obtained: Proposed decision versus real decision. Case of Church in the province of Zaragoza, Spain. *Source: Authors, 2022*



	Maintenance	Consoli-dation	Repair	Restora-tion	Rehabi-litation	Non-inter-vention	Inter-vention
Proposed action	0%	50%	65,00%	90,00%	87%	0%	73,00%
Real action	0%	50%	50%	67%	63%	0%	57,32%

Figure 4. Graph of the percentages of coincidence/difference obtained: Proposed decision versus real decision. Case of the Algerian commercial galleries. *Source: Authors, 2022*

Table 6. Identification of cases studied, parameterization of sub-values, and intervention decision. *Source: Authors, 2022*

Cases studies		**Typology/ Era**	**Normalized, weighted parameterize sub-values Σ=[0–30]:(C.7)**	**Proposed Decision Matrix-1 Result: Interest [21] No Need [3] Feasibility [9]**	**Real Decision Taken result**
Spanich cases	Case.1: XII century church in the province of Zaragoza	Religious 12th century	15,42 / 30	Intervention by priority	
	Case.2: Facades of an old administrative building in Madrid (54)	Administrative 16th century	18,16 / 30	Complete intervention on the facades	
	Case.3: Episcopal Palace in the province of Zaragoza	Cultural 14th century	14,37 / 30	Intervention by priority	
	Case.4: Patio of the Episcopal Palace in the province of Zaragoza (55)	Cultural 14th century	21,14 / 30	Complete intervention on the patio	
	Case.5: Residential building in Madrid	Residential 18th century	17,39 / 30	Complete intervention	
Algerian cases	Case.1: Algerian commercial galleries	Commercial 20th century	17,01 /30	Complete intervention	
	Case.2: Museum of Algiers	Residential, then cultural 18th century	20,13 / 30	Complete intervention	Complete intervention projected decision but intervention by priority in real execution
	Case.3: House and adjoining houses, Kasbah of Algiers	Residential, 16-18th century	14,83 / 30	Intervention by priority	
	Case.4: Bastion in Algiers	Defensive, then Residential, 16-18th century	25 / 30	Intervention by priority	
	Case.5: Palace in the Bastion of Algiers	Residential, 16-18th century	20,57 / 30	Complete intervention	
	Case.6: Apartment buildings in Algiers	Residential, 20th century	12,73 / 30	Partial intervention	

12.5% repair, 0% restoration, and 6.25% rehabilitation). Both interventions reached the same conclusion with some variations, as the real-case analysis only considered integrity and historical values to ensure stability. The decision was to prioritize consolidation and repair. Our proposal involved a comprehensive analysis with a decision to prioritize and proceed with a total intervention in phases. Both intervention decisions prioritized consolidation actions followed by repair, differing in restoration and rehabilitation actions. Despite minor differences, there was significant similarity between the VEM and reality.

In the second case (Figure 4), the coincidence percentages also indicate a substantial similarity between reality and the VEM proposal. The suggested intervention for the early 20th-century commercial building in Algiers was 73% (with 12.5% consolidation, 16.25% repair, 21.7% restoration, and 22.5% rehabilitation), while the actual intervention was 57.32% (with 12.5% consolidation, 12.5% repair, 16.70% restoration, and 15.62% rehabilitation). Both arrived at the same decision of full intervention, prioritizing actions based on importance and urgency. In the real case, the main decision was made prior to the complete analysis of the building due to national policy strategy. Despite differing processes, both methods yielded similar results, advocating complete intervention through consolidation, repair, restoration, and rehabilitation. Any discrepancies were likely influenced by the urgency of opening the building.

Table 6 summarizes the coincidence percentages for the 11 cases in both countries, as depicted in Figure 5, comparing interventions proposed by VEM with those actually executed. It is evident that in both countries, similar intervention decisions were made with minor differences. Understanding these differences requires acknowledgment that the VEM method strives to consider all values, including those related to use and context, and can propose both conservation and various intervention options. Additionally, the percentages of different interventions proposed by VEM slightly exceed those of reality. This is considered normal, as labor costs significantly influence decisions, and intervention budgets are typically constrained.

For additional validation of the method's efficacy, the decisions derived from VEM were cross-verified using the Multi-Criteria Decision-Making Method (MCDM) with the Analytic Hierarchy Process (AHP) (48), tailored to our needs.

To this end, in two of the buildings studied we have set the intervention actions as *alternatives* (a. No intervention, b. Maintenance, c. Structural consolidation only, d. Repair of facades and roofs, e.Comprehensive rehabilitation, f. Comprehensive restoration), heritage values as *criteria* (1.Historical-artistic, 2.Technical, 3.Functional, 4.Contextual), and three *decision makers*. With this we have obtained results that are supposed to be objective given that all the posible agents involved in the process are taken into account.

We have generated the aggregate dominance matrices, with which we have built the tables of strengths and weaknesses of each action, the last column of which shows the difference between them, which indicates the relative quality of each action. The dominant and weakest actions are identified for the three decision makers, and an average for each action helps the possible final decision making.

The results of the two cases studied are shown in Tables 7.a and 7.b:

Church in the Province of Zaragoza (Table 7.a)

The three decision-makers (Heritage Commission, Ministry of Development and City Council) suggest coherence, rejecting non-intervention and mainly considering structural consolidation. Then, the repair of facades and roofs, and ultimately, the rehabilitation and comprehensive restoration.

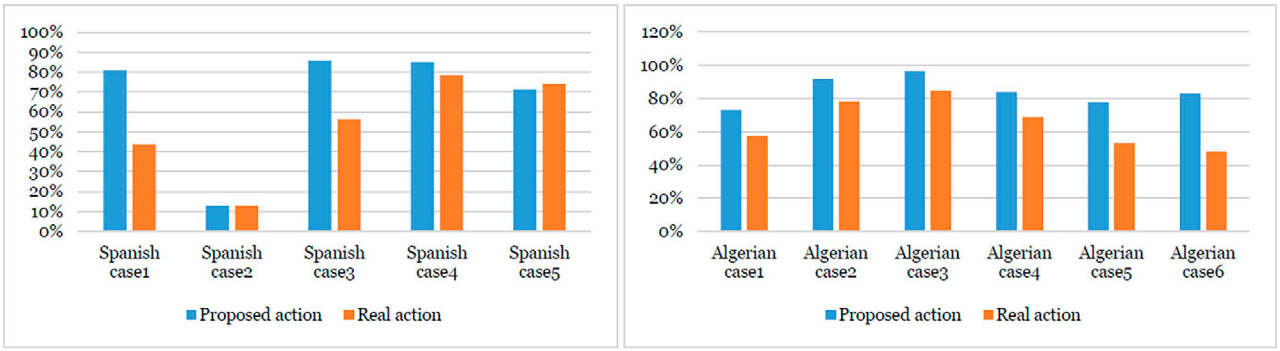


Figure 5. Graph of the percentages of coincidence/difference obtained: Proposed decision versus real decision of (a) the Spanish cases studied, (b) the Algerian cases studied; various types and numbers of specimens. Source: Authors, 2022

Table 7.a. Multicriteria System Application (AHP Method) for Intervention Decision-Making: Church in the Province of Zaragoza. *Source: Authors, 2022*

RANKING OF ACTIONS (QUALITY) — COMPARISON OF THE THREE DECISION-MAKERS												
ACTIONS	Strength				Weakness				Quality			
	HC	MP	MA		HC	MP	MA		HC	MP	MA	
Non-intervention	0	0	0	0	4	2	4	3,3	-4	-2	-4	-3,3
Structural Consolidation	1	3	1	1,3	0	0	0	0	1	3	1	1,3
Facade & Roof Repair	1	3	1	1,3	0	0	0	0	1	3	1	1,3
Comprehensive Rehabilitation	1	0	1	0,7	0	2	0	0,7	1	-2	1	0
Comprehensive Restoration	1	0	1	0,7	0	2	0	0,7	1	-2	1	0

Table 7.b. Multicriteria System Application (AHP Method) for Intervention Decision-Making: Algiers Commercial Galleries. *Source: Authors, 2022*

RANKING OF ACTIONS (QUALITY) — COMPARISON OF THE THREE DECISION-MAKERS												
ACTIONS	Strength				Weakness				Quality			
	MC	MD	AR		MC	MD	AR		MC	MD	AR	
Non-intervention	0	0	0	0	5	5	3	4,3	-5	-5	-3	-4,3
Maintenance	3	1	0	1,3	4	4	3	3,6	1	-3	-3	-1,6
Structural Consolidation	3	2	3	2,6	3	0	0	1	0	2	3	1,6
Facade & Roof Repair	3	2	2	2,3	4	0	1	1,6	-1	2	1	0,6
Comprehensive Rehabilitation	4	2	2	2,6	0	0	1	0,3	4	2	1	2,3
Comprehensive Restoration	3	2	2	2,3	0	0	1	0,3	3	2	1	2

Algiers Commercial Galleries (Table 7.b)

The three decision-makers (Ministry of Culture, Museum Management and Architect) seem coherent, rejecting non-intervention, and considering maintenance, structural consolidation, facade repair, rehabilitation and comprehensive restoration necessary according to the logical preferences of each one.

The results are quite similar to those given by the application of the VEM method, with the simplicity that this method involves a single person making decisions.

Overall, the results of applying the VEM indicated that each case required a specific intervention, either partial, by priority, or complete. In summary, we can affirm that the estimation of values included in our method significantly aids in the decision-making process for intervention, including the necessary actions to protect and recover existing buildings. In fact, in real cases, stakeholders often make subjective decisions that need coordination among them to be objective. However, our proposal takes into account all the values, parameterizes and weighs them, making it easier for a single expert decision-maker to make an objective decision.

7. CONCLUSIONS

In conclusion, safeguarding architectural heritage requires a unified approach centered on protecting its inherent values. The VEM emerges as a valuable tool for identifying, classifying, and evaluating these values, providing a comprehensive framework for intervention decisions. Key highlights from our study include:

1) **Value-Driven Interventions:** The VEM guides intervention decisions by parameterizing values qualitatively and quantitatively. Three *critical conditions* (interest, necessity, and feasibility) determine whether to intervene. Five *levels of intervention* (total, partial, by priority, no intervention, and maintenance only). Three actions types (Repair/Consolidation, Restoration, and Rehabilitation) based on evaluated value improvement needs.

2) **Expert Decision-Making:** The VEM relies on a single expert decision-maker, facilitating a comprehensive and objective decision-making process. This simplicity contrasts with the complexity introduced by multiple decision-makers in real interventions. Consistent comparative results between VEM and MCDM applications across two cases underline the reliability of the method.

3) **Holistic Approach:** The VEM sheet offers an accessible and consistent approach to hierarchical, organized, and simplified decision-making. It is applicable to diverse values, entire or partial buildings, urban or rural areas, and built entities or landscapes.

4) **Scientific Rigor:** The VEM provides a scientific and justified approach to architectural heritage, solving built asset management problems with analytical methods, with stakeholder participation, and with legal frameworks. The VEM sheet serves as a scientific basis for both research and practical applications in architectural heritage conservation.

5) **Future Considerations:** As climatic challenges and societal adaptations gain prominence, protecting architectural values becomes critical. The VEM stands as a practical and objective method to guarantee the correct conservation of heritage structures.

In short, the VEM represents a novel contribution to architectural heritage research and management, characterized by an objective, justified, and proven reliable method. The presented coincidence percentages affirm its acceptance as an accessible and consistent approach for making hierarchical, organized, and simplified intervention decisions.

DECLARATION OF COMPETING INTEREST

The authors of this article declare that they have no financial, professional or personal conflicts of interest that could have inappropriately influenced this work.

AUTHORSHIP CONTRIBUTION STATEMENT

Fatima Benchenni: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing – original draft, Writing – review & editing.

Abdelkader Mebrouki: Data curation, Project administration, Resources, Supervision, Validation.

Juan Monjo-Carrió: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization.

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