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Modelo matemático para dar soporte en la evaluación patológica y su integración en herramienta web.
Mathematical model to support pathological assessment and its integration into a web tool.

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Resumen-- **Este modelo matemático evalúa varios requisitos de calidad como la seguridad, la habitabilidad, la funcionalidad o, incluso, la estética. En su elaboración, se ha pretendido que fuera comprensible para el mayor número de usuarios. Esto se traduce en una simple ponderación que puede expresarse de la siguiente manera:**

GP = E + H + F + So + Se

Su uso es muy simple, el técnico que evalúa los daños de un inmueble a menudo debe rellenar unos campos para categorizar y analizar sus datos. Estos campos se han representado en un formulario donde, cada dato, lleva incorporado un valor numérico. A su vez, este formulario, está integrado en una herramienta web por lo que se obtienen automáticamente valores numéricos según se introduce la información.

A lo largo de este artículo, se desarrollará el funcionamiento de este modelo matemático, se expondrán las variables que se tienen en cuenta y se mostrará cómo puede dar soporte para la toma de decisiones.

Palabras clave— Modelos matemáticos; BIM; Evaluación de daños; Patología, Herramientas web.

Abstract— **This mathematical model evaluates various quality requirements such as safety, habitability, functionality and even aesthetics. In its development, it was intended to be understandable for the greatest number of users. This translates into a simple weighting that can be expressed as follows:**

GP = E + H + F + So + Se

Its use is very simple, the technician who assesses the damage of a building often has to fill in some fields to categorise and analyse his data. These fields are represented in a form where each piece of information has a numerical value. This form, in turn, is integrated into a web tool so that numerical values are automatically obtained as the information is entered.

Throughout this article, the operation of this mathematical model will be developed, the variables taken into account will be explained and it will be shown how it can support decision-making.

Index Terms— Mathematical modelling; BIM; Damage assessment; Pathology, Web tools.

I. Introduction

THE digitisation mentioned in the subsection Processing and analysis of The idea for the tool is nothing more than the transformation of reality into values that can be understood by a computer.

An example would be the representation of a colour by means of a code such as hexadecimal. This allows us to see on a screen the colour interpreted by the computer thanks to these characters (Fig. 1).

In the same way that colours can be assigned values, it is also possible to act in the same way with other elements of reality such as pathologies and the data associated with them.

In this way, an analytical capability can be achieved to quantify the dangerousness of a pathology by means of a formula.

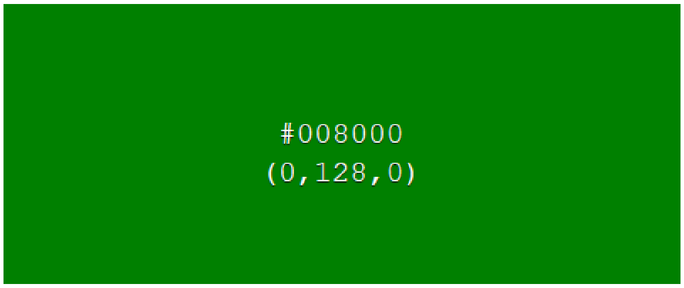

Fig. 1. Graphical representation of a colour with its corresponding hexadecimal code and RGB code. Source: https://www.color-hex.com/color/008000.

It should be noted that this is not the first initiative to provide a numerical value in the quantification of damage, the difference in this mathematical model is that it evaluates various quality requirements such as safety, habitability, functionality or even aesthetics.

Likewise, mention will be made of a web tool that was already the subject of a communication in 2021 in which the functionalities were detailed, the main one being the registration of pathologies of a building in the most efficient way possible.

A. *Purpose*

Before defining the purpose of this method of quantification, it should be noted that certain aspects are still weighted, which, in future versions, can be refined with more studies and opinions. In addition, there are intrinsic and extrinsic reasons for the creation of this formula.

The intrinsic and immediate functional reasons are to help the user of the application to evaluate each pathology, not only by means of tables but also in a graphical and quantitative way that will be useful for decision-making.

But the most important reasons for its potential impact are the extrinsic reasons of making the formula public and open to modifications. It is for all these reasons that we have tried to make it as simple as possible so that any agent (institution, professional or company) that wishes to participate can propose changes in order to make it more adjusted and with the same capacity for evolution that the construction sector will have.

This idea is also based on the history of the CVSS system, which has its origins in FIRST, an institution in which 421 teams from more than 70 countries participate and which published a draft in 2014 that culminated in 2015 with the definitive publication of the third version of this evaluation system, considering the new technological contexts and current threats.

Likewise, this formula is only the beginning of a model for assessing the danger of pathologies so that the technician has another tool to help him solve dilemmas such as, for example, when there are scarce economic resources and priority must be given to providing solutions that remedy the damage to a building with the greatest impact in order to increase its quality.

B. *Formula origin*

This idea stems from the Common Vulnerability Scoring System (CVSS) for quantifying computer security vulnerabilities. It is a scoring system that provides a standard and open method consisting of three main groups of metrics: Baseline, Temporal and Environmental (Fig. 2). Each of these groups is in turn composed of a set of metrics according to their nature.

It is on these groups of metrics that the formula for quantifying what will be called the Quality Requirements of the building is based.

C. *The quality requirements of a building*

In order to extract the requirements to be taken into account to quantify the quality that a building must have, we have started from the rules of the Spanish Technical Code (CTE) that were approved by the ROYAL DECREE 314/2006 of 17 March. These standards in the form of basic requirements are made up of different parts according to their scope of application:

- Basic structural safety requirements (SE).
- Basic fire safety requirements (SI)
- Basic requirements for safety in use and accessibility (SUA)
- Basic health and safety requirements (HS). "Hygiene,

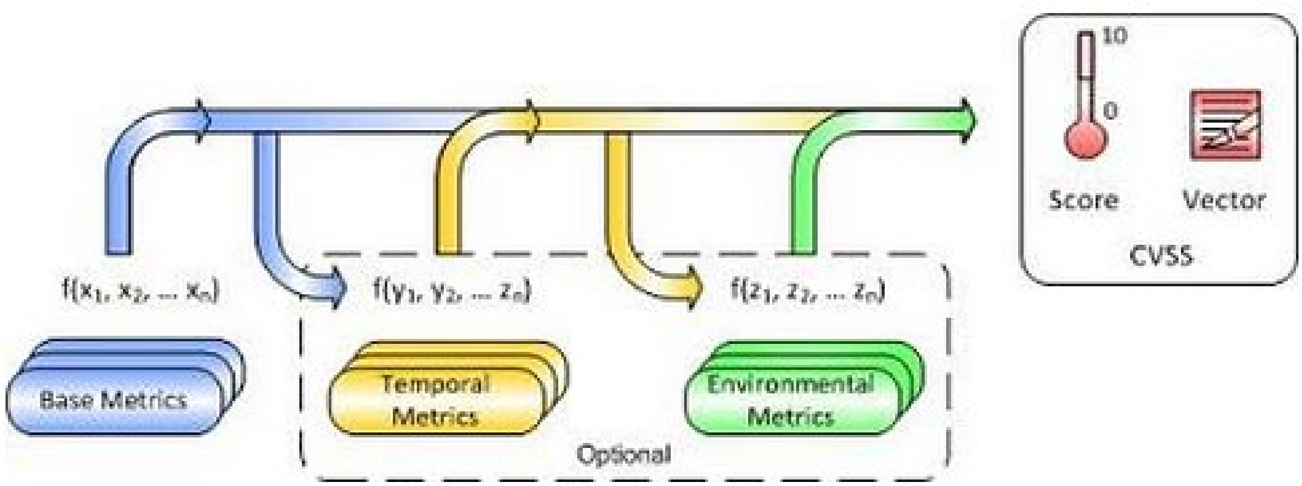

Fig. 2. Version 2 metrics and equations. Source: https://www.certsi.es/blog/cvss3-0.

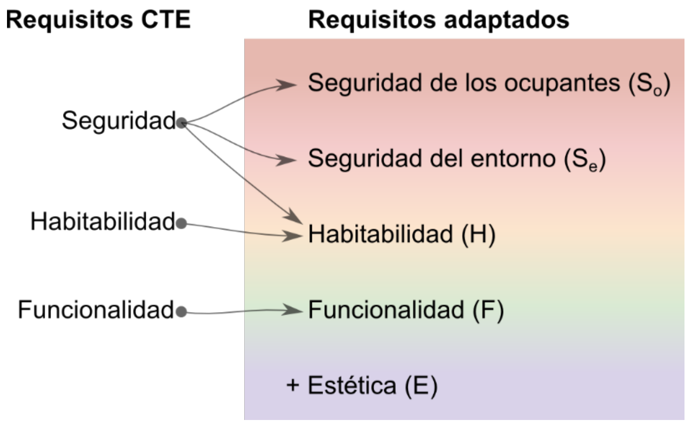

Fig. 3. Adaptation of requirements based on CTE. Source: Own elaboration.

health and environmental protection".

- Basic noise protection requirements (HR).
- Basic energy-saving requirements (HE).

From this list of basic requirements, three requirements can be perceived that a building must have in order to meet the quality and comfort appropriate to its use:

- Safety
- Habitability
- Functionality

It should be noted that the formula model could have been oriented towards quantifying the effect that each pathology would have on the aforementioned basic requirements. This, which a priori may be useful, would not be very operative if an attempt were made to internationalise this formula adapted to Spanish standards, i.e., the quantifications expressed in the CTE documents will, in isolated cases, be the same as those of other countries. Therefore, the aim has been to extract requirements that are common to every building in the world in order to facilitate their future understanding, use and scalability.

Continuing with the three requirements extracted from the CTE, it has been considered convenient to make slight modifications by renaming some requirements and adding others to adapt the damage affectations produced by the pathologies (Fig. 3).

In order to be able to work better with these requirements, it is convenient to define them and to clarify why they have been modified or included for quantification purposes:

1) *Occupant safety*

This requirement refers, as safety is defined, to the absence of danger or risk, in this case, to the occupants of the building. This refers to the situation where they are inside the habitable spaces of the building.

2) *Safety of the surroundings*

In contrast to the previous requirement, this absence of danger or risk refers to the exterior of the building, including non-habitable spaces, i.e., interior courtyards, exterior façades, etc.

It has been considered appropriate to separate the safety of the interior from that of the exterior of the building in view of the cases in which part of a deteriorated building affects pedestrians, causing tragic incidents.

3) *Habitability*

This is the part of this discipline dedicated to ensuring minimum conditions of health and comfort in buildings. In particular, habitability is concerned with thermal and acoustic insulation and healthiness.

This requirement to be evaluated has been included in the formula treated because it is explicitly demanded in the basic requirements of the CTE which, in turn, is based on the Ley de Ordenación de la Edificación (LOE) as provided for in article 3.1 :

c) Related to habitability:

c.1) Hygiene, health and environmental protection, in such a way that acceptable conditions of salubrity and watertightness are achieved in the interior environment of the building and that the building does not deteriorate the environment in its immediate surroundings, guaranteeing adequate management of all kinds of waste.

c.2) Protection against noise, in such a way that the perceived noise does not endanger people's health and allows them to carry out their activities satisfactorily.

c.3) Energy saving and thermal insulation, so as to achieve a rational use of the energy necessary for the proper use of the building.

c.4) Other functional aspects of the construction elements or installations which allow satisfactory use of the building.

4) *Functionality*

Article 3.1 of the Ley de Ordenación de la Edificación (LOE) has been taken as a reference to define this requirement:

a) Related to functionality:

a.1) Utilisation, in such a way that the layout and dimensions of the spaces and the provision of the installations facilitate the adequate performance of the functions foreseen in the building.

a.2) Accessibility, in such a way that people with reduced mobility and communication are allowed to access and move around the building under the terms provided for in its specific regulations.

a.3) Access to telecommunication, audiovisual and information services in accordance with the specific regulations.

a.4) Facilitation of access to postal services, through the provision of appropriate facilities for the delivery of postal items, in accordance with the provisions of their specific regulations.

For these reasons, it is considered when assessing it as one of the variables in the proposed formula.

5) *Aesthetics*

This is a very broad and subjective characteristic which, in the area we are concerned with, is simply reduced to the modifications that a pathology produces in a building without being contemplated in the project and which can be appreciated visually.

With this premise, it can be affirmed that when a building is affected by damage that can be seen with the naked eye, the aesthetic qualities of the building have been compromised.

6) *The relationship of the quality requirements with the CTE*

In order to better understand the impact of these

TABLE I
RELATION OF QUALITY REQUIREMENTS WITH THE RELATION TO THE BASIC DOCUMENTS OF THE CTE.

	SE	SI	SUA	HS	HR	HE
Aesthetics						
Habitability				x	x	x
Functionality		x	x	x	x	x
Occupant safety	x	x	x			
Safety of the environment	x	x	x			

requirements, a relationship is established between them and the requirements they affect (Table 1).

The table shows how the CTE does not assess the aesthetic value of a building, remaining only in the quantitative values that allow the process of creating a building to be guided in an objective and practical way in order to achieve quality standards.

II. METHODOLOGY

A. Formula

$$GP = E + H + F + S_o + S_e \qquad (1)$$

The aim was to make it comprehensible to the greatest number of users, resulting in a simple weighting of the five quality requirements that may be compromised as a result of the appearance of a pathology. However, it is important to emphasise that this formula is a first version and will certainly be improved with experience and the involvement of technicians and users.

The weighting takes into account the majority use of the property and is therefore also a variable to be taken into account, as will be developed later on.

The affected requirements have, in turn, a series of coefficients that can reduce their value based on different parameters entered through the form of the tool, which would leave the formula as follows:

$$GP = e \times C_e \times \%e + h \times C_h \times \%h + f \times C_f \times \%f + s_o \times C_{so} \times \%so + s_e \times C_{se} \times \%se \qquad (2)$$

Where:

- GP: Pathology severity. Final value between 0 and 10.
- e: Gross aesthetic factor taken from a matrix according to the typology of the pathology.
- h: Gross habitability factor taken from a matrix according to the typology of the pathology.
- f: Gross functionality factor taken from a matrix according to the typology of the pathology.
- so: Gross occupant safety factor taken from a matrix according to the typology of the pathology.
- se: Gross environment safety factor taken from a matrix as a function of the typology of the pathology.
- Ce: Coefficient of reduction of e.
- Ch: Coefficient of reduction of h.
- Cf: Coefficient of reduction of f.
- Cso: Coefficient of reduction of so.
- Cse: Coefficient of reduction of se.
- %: Weighting according to the majority use of the property.

The final result would be a value between 0 and 10, with the higher the value obtained, the more serious the damage.

B. Parameters to consider.

Among all the parameters that are defined when recording a pathology, those that could best quantify the damage have been selected. It should also be noted that not only the parameters specific to the damage should be considered, but in order to assess the severity more accurately, some parameters specific to the building should be taken into account and which, therefore, will affect the other pathologies recorded that are associated with it, which leads to establishing two groups of parameters:

- Those specific to the building:
- Majority use of the building
- Those specific to the pathology:
- Type of pathology
- Element
- Affects structural element
- Evolution of the lesion
- Danger to stability
- Urgency of intervention
- Imminence of risk

Each of these will be quantified differently when contributing data to the formula.

C. Future parameters to be taken into account

Other parameters have not been considered for this first version of the formula because it was not considered appropriate to include them or because of the complexity involved in giving values for them. Those that are being assessed for inclusion in future versions are:

- Those specific to the property:
  - Building typology: The development of these typologies is based on the Building Evaluation Report (IEE) proposed by the Ministry of Development. This classification of the building has not been taken into account as its use multiplied the possible values depending on the use of the building. In future versions it will be integrated in a way that it can be easily identified.
  - Evaluated building: Its implementation has been omitted as its influence on the severity of a pathology has not been detected.
- Those specific to the pathology:
  - Date of visit: This field can be very useful in the future because it allows increasing the severity of the damage as it becomes more distant with the current date.
  - Type of injury: These are defined according to the nature of the injury (physical, mechanical or chemical) but, as this input is directly related to the type of injury, it can be ignored in the short term until statistical data is available.

Fig. 4. Crack in facing brick façade. Source: https://www.redpiso.es/news/los-vicios-ruinogenos/

- Cause: In principle, if an injury has already occurred, the cause of its occurrence is independent of its severity. To draw a comparison with damage to the human body, when a wound affecting a major artery has occurred, the result is very serious, whether it is a stabbing or a fall on a sharp object. But it is worth bearing this parameter in mind as, when pathology-cause relationships are established, it will help to generate proposals for action.
- Estimated valuation: This field could not be included due to the lack of statistical data linking the type of pathology to an economic quantification of the cost of repair.

III. Results

Having explained the approach of the formula and the parameters it considers when providing a numerical value for a given damage to a building, the procedure is detailed below:

To obtain the necessary data and to be able to calculate the severity of the damage, three steps must be followed which will lead us through matrices according to various parameters:

1. Find out the gross condition values of the requirements according to the pathology.
2. Find out the reduction coefficients based on the element affected by the pathology.
3. Find out the weighting according to the main use of the property.

In order to better clarify its use, each of the steps has been worked on according to an example where the data of a pathology (Table 2) has been introduced as it would be done in the tool.

A. Determine the gross condition values of the requirements according to the pathology.

The table shows the maximum values that a type of pathology can have in terms of the requirements defined above. As can be seen, these are values between 0 and 10, which will subsequently be reduced to a greater or lesser extent by other parameters defined in the application.

Table II
Example data for the use of the formula.

Pathology	Cracks
Element	Exposed brick façades
Structural element	No
Evolution	Stable
Danger to stability	Medium
Urgency	Medium
Imminent risk	No
Use of the building	Private residential

1) Example:

We take the values in the table for the pathology type defined as "Cracks/Cracking" and we obtain that:

- e = 10
- h = 10
- f = 10
- s_o = 10
- s_e = 10

Table III
Gross condition values of the requirements depending on the pathology.

	e	**h**	**f**	**so**	**se**
Biological attack	10	5	5	5	5
Clogging and/or malfunctioning of installation	5	5	10	5	5
Missing or poorly positioned	10	10	10	10	10
Corrosion/oxidation	10	5	10	10	10
Aesthetic damage	10	5	0	0	0
Finish defects	10	10	5	0	0
Material degradation and/or decomposition	10	10	10	10	10
Slippage	10	10	10	10	10
Landslides	10	10	10	10	10
Detachment/lifting	10	10	10	10	10
Dysfunctions	5	10	10	5	5
Efflorescence	10	0	5	0	5
Clogging	10	10	10	10	10
Cracks/Cracks	10	10	10	10	10
Moisture	10	10	10	10	10
Joints between parts	10	10	10	10	10
Bad smells	0	10	10	10	10
Stains/dirt and/or staining	10	5	5	5	5
Joint manifestation with walls	10	10	10	10	10
Buckling	10	10	10	10	10
Perception of noise beyond admissible limits	0	10	10	5	7,5
Loss of cross-section	10	0	10	10	10
Air permeability	0	10	10	5	0
Planimetry	10	5	5	0	0
Slipperiness	0	10	10	5	5
Other					

Thus becoming:

$$GP = 10 \times C_e \times \%e + 10 \times C_h \times \%h + 10 \times C_f \times \%f + 10 \times C_{so} \times \%so + 10 \times C_{se} \times \%se$$

B. Determine the reduction coefficients based on the element affected by the pathology.

$$GP = e \times \boldsymbol{C_e} \times \%e + h \times \boldsymbol{C_h} \times \%h + f \times \boldsymbol{C_f} \times \%f + so \times \boldsymbol{C_{so}} \times \%so + se \times \boldsymbol{C_{se}} \times \%se$$

Once the values of the requirements have been obtained, we proceed to find out the coefficient according to the element affected by the pathology and one of the parameters defined in the application.

It should be considered that, if the user has marked the pathology as an imminent risk, the GP value automatically becomes the maximum.

The coefficients are obtained from tables where the result will be the average of the different parameters defined. This is because the different parameters have, in this first version of the formula, the same importance when it comes to quantifying the severity of a pathology and, therefore, it cannot be ruled out that in the future they may be used in a different way.

It has been decided that, due to their size, the tables in which the reduction coefficients appear should be left out of this communication. These tables will be published on the website a few days before the congress.

As there are parameters that do not affect the obtaining of certain coefficients, the following table (Table 4) has been drawn up to show which parameters affect each of the coefficients.

TABLE II
EXAMPLE DATA FOR THE USE OF THE FORMULA.

	C_e	C_h	C_f	C_{so}	C_{se}
Structural element				x	x
Evolution of the injury	x	x	x	x	x
Danger to stability		x	x	x	x
Urgency of intervention		x	x	x	x
Immanent risk	x	x	x	x	x

*It shall affect where there is imminent risk

1) Example:

In the damage proposed as an example, each of the coefficients to be ascertained is broken down as follows:

1. In the table corresponding to the aesthetic coefficients, the value of the row of the affected element and the evolution of the injury must be taken:

In this case, as there is only one parameter affecting the aesthetic coefficient, it would not be necessary to calculate the average of the values and therefore: $C_e = 0,75$.

2. For the habitability coefficient, from the corresponding table, we obtain the value, so by averaging we get the value: $C_h = 0,50$
3. For the functionality coefficient, whose value is $C_f = 0,58$
4. For the occupant safety factor value is $C_{so} = 0,63$
5. For the safety factor of the environment value is $C_{se} = 0,63$.

TABLE III
VALUES OF THE COEFFICIENTS AS A FUNCTION OF THE EXAMPLE PARAMETERS

	C_e	C_h	C_f	C_{so}	C_{se}
Structural element				0,75	0,75
Evolution of the injury	0,75	0,50	0,75	0,75	0,75
Danger to stability		0,50	0,50	0,50	0,50
Urgency of intervention		0,50	0,50	0,50	0,50
Immanent risk	-	-	-	-	-
Mean value	**0,75**	**0,50**	**0,58**	**0,63**	**0,63**

All of this can be summarized in Table 3, which when inserted into the formula for the example would look like this:

$$GP = 10 \times \boldsymbol{0,75} \times \%e + 10 \times \boldsymbol{0,50} \times \%h + 10 \times \boldsymbol{0,58} \times \%f + 10 \times \boldsymbol{0,63} \times \%so + 10 \times \boldsymbol{0,63} \times \%se$$

C. Determining the weighting according to the majority use of the property

$$GP = e \times C_e \times \boldsymbol{\%e} + h \times C_h \times \boldsymbol{\%h} + f \times C_f \times \boldsymbol{\%f} + s_o \times C_{so} \times \boldsymbol{\%so} + s_e \times C_{se} \times \boldsymbol{\%se}$$

This weighting is the values recorded in the table below:

TABLE IV
WEIGHTINGS IN PERCENTAGES ACCORDING TO THE MAJORITY USE OF THE PROPERTY.

	%e	**%h**	**%f**	**%so**	**%se**	
Public residential	0,05	0,30	0,20	0,40	0,05	1,00
Private residential	0,05	0,30	0,20	0,40	0,05	1,00
Administrative	0,05	0,20	0,30	0,40	0,05	1,00
Educational	0,05	0,20	0,30	0,40	0,05	1,00
Commercial/public	0,10	0,15	0,30	0,40	0,05	1,00
Industrial	0,05	0,10	0,40	0,40	0,05	1,00
Sanitary	0,05	0,20	0,30	0,40	0,05	1,00
Monumental	0,35	0,05	0,15	0,40	0,05	1,00

The values signify the importance of the affected requirements according to the majority use of the building, which can be more clearly expressed as a percentage are shown in Table 5:

TABLE V
PERCENTAGE WEIGHTINGS ACCORDING TO THE MAJORITY USE OF THE PROPERTY.

	%e	**%h**	**%f**	**%so**	**%se**	
Public residential	5%	30%	20%	40%	5%	1,00
Private residential	5%	30%	20%	40%	5%	1,00
Administrative	5%	20%	30%	40%	5%	1,00
Educational	5%	20%	30%	40%	5%	1,00
Commercial/public	10%	15%	30%	40%	5%	1,00
Industrial	5%	10%	40%	40%	5%	1,00
Sanitary	5%	20%	30%	40%	5%	1,00
Monumental	35%	5%	15%	40%	5%	1,00

When assessing the weighting, the majority use of the property should be considered, as in some cases some requirements may be more important than others.

Such is the case of a monumental versus a residential use, where the aesthetic requirement is more important in the first case, as the property is a property that is used for its aesthetic value.

1) Example:

In the case of the building where the damage under discussion has occurred, the majority use is public residential. This means that the weightings would be as follows:

- %e = 0,05 = 5%
- %h = 0,30 = 30%
- %f = 0,20 = 20%
- %so = 0,40 = 40%
- %se = 0,05 = 5%

This leaves the formula with all the data defined and ready to be evaluated:

$$GP = 10 \times 0{,}75 \times \mathbf{0{,}05} + 10 \times 0{,}50 \times \mathbf{0{,}30} + 10 \times 0{,}58 \times \mathbf{0{,}20} + 10 \times 0{,}63 \times 0{,}40 + 10 \times 0{,}63 \times \mathbf{0{,}05}$$

By first obtaining the calculated condition values for each requirement and then obtaining the GP value:

$$GP = 0{,}38 + 1{,}50 + 1{,}16 + 2{,}52 + 0{,}32 = \mathbf{5{,}88}$$

This value by itself would be irrelevant if it were not for the ranges that have been established in order to transform them into an indicative form of action as will be developed in section 4 of this communication.

IV. Conclusions. Value-based performance.

As in the CVSS system, and following the parallelism with which this section began, a series of levels have been established according to ranges and shown in Table 6.

With these estimates of the possible GP values, it is possible to propose forms of action that are translated into maximum intervention periods for each level.

To establish these periods, DECRETO 241/2012 of 21 November 2012 has been taken as a reference, specifically Article 12.j :

j) Nature of the types of intervention, which may be immediate, very urgent, urgent, urgent, necessary in the medium term and/or maintenance, understood as follows:

Grade 1 intervention to be adopted within a maximum period of 24 hours, calling in the fire-fighting service if no other means are available, in cases of a confluence of extreme deterioration, with risk of collapse of the element and with imminent risk of damage to people or property, and when it is necessary to adopt safety measures such as shoring up, eviction, closing access to an area of the building, installing safety trays to prevent landslides, etc.

Grade 2 intervention associated with significant damage to parts of the building or its elements, which entail a short-term risk to people or property, but for which it is considered that, due to their state of degradation, the maximum period to be established for this type of action should be three months, regardless of whether or not auxiliary safety measures are required.

Grade 3 intervention when serious deficiencies are detected, which could lead to the progressive degradation of the element or system. The maximum period to be established for this type of action is twelve months.

Grade 4 to be associated with specific deficiencies, which do not affect the functioning of the system and which require specific action, since if they are not corrected, they may degenerate into a pathological process of greater magnitude. In this case, actions that can be postponed for more than one year can be considered.

Grade 5 when no lesions have been detected, or when these, due to their slightness, do not apparently entail a risk, as with appropriate maintenance they can be corrected or their progression halted, this being understood as the set of operations and care to be carried out periodically to prevent the deterioration of a building and keep it in good condition.

All this can be summarised as shown in Table 7 and taken to the possible GP values, we would be left with the following ranges with their corresponding timeframes for action:

As for the GP ranges, these have changed with respect to those of the CVSS system, as the interpretation of severity differs from the field of building pathologies to that of computer security. It is also worth mentioning that, nominally, the levels of the CVSS system have been taken as they are more descriptive with the consequent form of action.

In order to see its application in a pragmatic way, the GP value of the example used can be used with the formula:

$$GP = 5.88$$

Table VI
Correspondence between CVSS score and qualitative value (severity). Source: https://www.certsi.es/blog/cvss3-0

CVSS Punctuation			Severity
		0	None
0,1	~	3,9	Low
4	~	6,9	Medium
7	~	8,9	High
9	~	10	Critical

Table VII
Summary of timeframes for action according to the degree of injury

Grade	**Deadline for action**	
5		Maintenance
4	>	12 months
3	<	12 months
2	<	3 months
1	<	24 hours

TABLE VIII
TIMEFRAMES FOR ACTION ACCORDING TO GP SCORE AND SEVERITY RANGES.

GP Punctuation			Severity	Deadline for action
		0	None	Maintenance
0,1	~	3,9	Low	> 12 months
4	~	5,9	Medium	< 12 months
6	~	8,9	High	< 3 months
9	~	10	Critical	< 24 hours

With the established levels, the pathology with this value would have a medium severity, which translates into an action period of no more than 12 months.

Recalling its parameters, this is damage to a façade in the form of a crack or fissure that is in a stable state and that, according to the criteria of the user with a technical profile who entered the data in the tool, it was considered appropriate to have a medium intervention urgency given, among other factors, the danger to the stability of the pathology. Therefore, the period of action suggested by the established levels and more specifically the proposed formula can be considered consistent and correct for this first version of the system for assessing the seriousness of a pathology.

It should be stressed that this system is still in its infancy, as it is a first version subject to change depending on various factors. This formula must continue to evolve in order to provide feedback and to be fine-tuned in the future in order to increase its analytical potential.

V. APP WEB CONNECTION

On the occasion of this communication, a web calculator has been made available to test this formula. In this calculator, the user can enter the necessary data to quantify the degree of danger of any damage (Fig. 6).

Then, the user only needs to click on the "Calculate" button to find the value of the degree of danger with the corresponding information on the timeframe for action (Fig. 7). At this point, the process developed in points 3 and 4 has been carried out, in such a way that the qualities affected in the building due to the damage that has been introduced can also be detailed, in addition to knowing the recommended action period.

Fig. 5. QR code to link to GP value calculator.

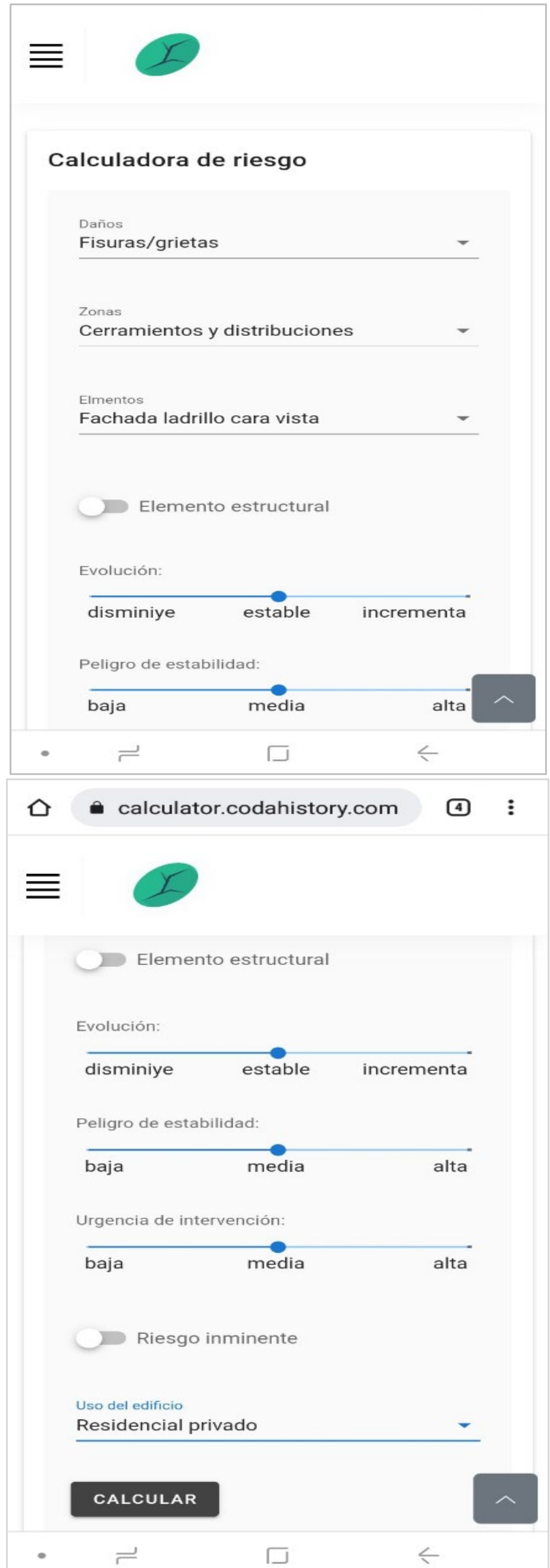

Fig. 6. Data entry in the tool's calculator. Source: https://calculator.codahistory.com/

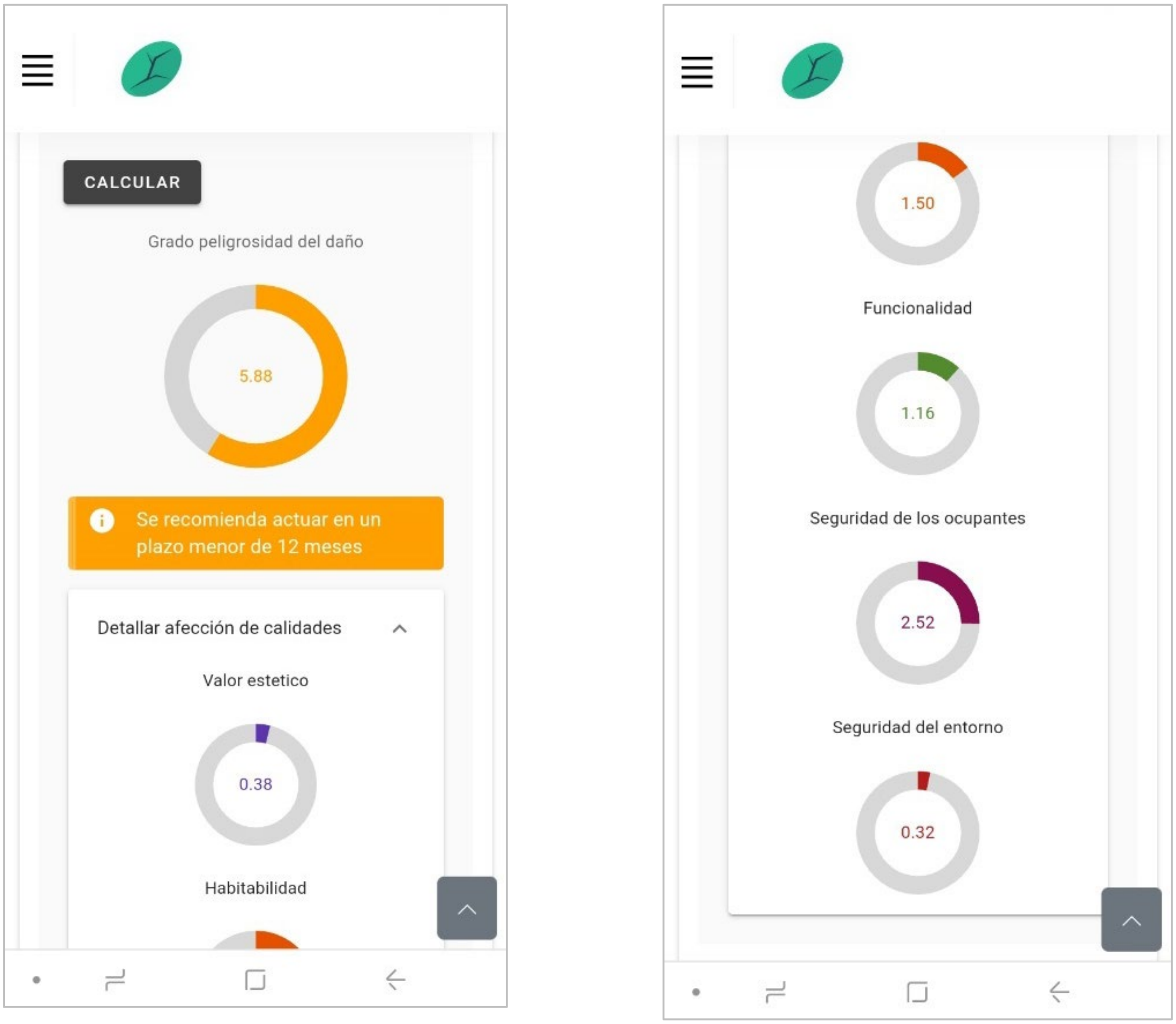

Fig. 7. Results obtained in the tool's calculator. Source: https://calculator.codahistory.com/

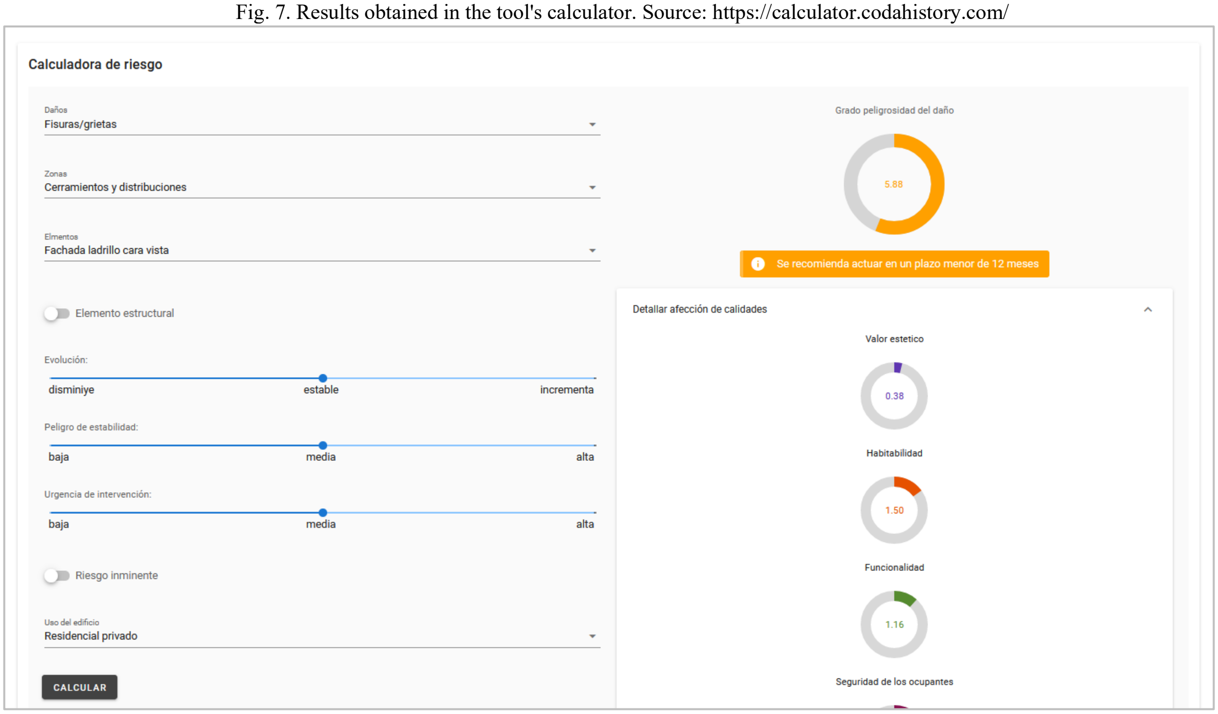

Fig. 8. Data input (left) and display (right) in web calculator viewed from a desktop browser. Source: https://calculator.codahistory.com/

The entire website has been developed as a landing page, centralising the information in a single link. Also, due to the growing use of mobile devices, the relevant techniques have been used to make this website a responsive entity, so that it can be viewed comfortably both from a smartphone browser and a desktop web browser (Fig. 8).

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