RISK AND VULNERABILITY OF CONTEMPORARY ART: A NEW CHALLENGE?

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Abstract: In this paper, risk and vulnerability assessment of contemporary art is discussed. The degradation of materials and structures of contemporary art is mainly due to deterioration caused by static-structural damage, weathering, pollution and anthropogenic damage as art-works of previous period, nevertheless the innovation in materials, design and structures, may imply new challenges that need to be studied.
The vulnerability of three domes of the Faculty of Visual Arts, designed by Ricardo Porro Hidalgo between 1961-1965 in La Habana (Cuba), has been the subject of our study. A model of vulnerability and risk based on the state of conservation and its relationship with static and structural factors, climatic conditions, air quality, level of usage, cataloguing and constructive simplicity has been employed. The vulnerability indexes were calculated based on a Leopold matrix that depends on intrinsic variables and the life of the monuments. The result reproduces human reasoning to study relations between vulnerability, risk factors and state of conservation of contemporary monuments. New designs and contemporary materials such as those that were used by Ricardo Porro Hidalgo in this monument imply modifications in the study of vulnerability indexes.
Working with contemporary monuments implies adapting these vulnerability and risk methodologies, because of the new materials and methods used by architects and artists, which implies that the conservation and restoration of contemporary artworks and buildings entails the development of guidelines based in investigation and diagnostics, which suppose a new discipline and a great challenge in the 21st century.

Keywords: risk, vulnerability, contemporary architecture

1. INTRODUCTION

Development in science and technology, as well as in experimentation and new artistic expressions, has kick-started a revolution regarding the kinds of materials we can find in contemporary artworks. This experimentation, the usage of new materials and procedures, which starts at the end of the 18th century, implies the emergence in artistic heritage of a great variety of new materials and processes. This proliferation of techniques and materials, key characteristic of modern and contemporary art, make its preservation a complex discipline that differs from traditional restoration, difficult to regulate or standardize with clear methodologies and criteria [1,2].

We must be aware, that any kind of material, object or structure can be nowadays transformed into an artwork, and because of that, diagnostics and restoration should be expanded to materials that could be very diverse. Some of the artworks that we find today in modern art galleries and private collections are made with materials with low stability that can degrade by themselves or are combined with each other in incompatible or perishable manners. Works of art such as those done by Tim Noble and Sue Webster from garbage and food-based art by Jason Rhoades, used chemically perishable materials, whilst the plexiglass used by artist Thobias Rehberger, are characterized by the use of soft and flexible materials, so it is difficult for stable structures to be preserved, as they suffer from great structural instability. To all of those chemical and physical changes they could suffer, we should also take into account that maybe the artist made the artwork so it would be perishable. So, with these kinds of artworks we are presented with a dilemma, because its conservation implies modifying the artists' opinion or distorting it.

In contrast with artworks in galleries and private collections, in contemporary architectural pieces, these new shapes and combinations of materials often defy gravity and/or stability [4], furthermore generating a dichotomy between longevity and innovation, not unreasonably, as many of these buildings are more fragile and more temporal artworks [5]. Furthermore, context and situation of the new piece is and inseparable part of the piece itself, such as in Antony Gomeley's "Otro lugar", where the statues location next to the sea is very important, even considering the damage it could cause the statues, which makes necessary now do a study of the binomial combination between the piece and its environment. While the classical preservation and restoration criteria were clearly defined by the letters and quality standards, the guidelines for restoration of contemporary art require new approaches to formulate specific instructions as they have to be applied to a huge ranges of materials and designers for collections and buildings [6–8], and therefore a new approach in the context of higher learning [9].

From the point of view of diagnostics, criteria when working with contemporary art must follow a full and new approach, based in the historic and artistic study of these artworks with a special focus on the artist and their interviews [10], the investigation of the new materials (plastics, light, food, kinetic art, rubbish, or re-used objects, sound and images, digital supports…) [11,12] and the context of environmental influence [10]. Similar approach was carried out in the restoration of the Eames House [13], getting a good result. However, it is in intervention criteria where more differences between cultural and contemporary heritage emerge, given that while in cultural heritage, the effort tends to go towards the preservation of matter, interventions on contemporary buildings suggest a dichotomy between the prevalence of matter and the function [14]. In this context, apart from a few cases where the first approach has been chosen [15], the idea of reconstruction usually prevails [16] or an adaptation towards other usages [17], which implies the introduction of new materials and structures, adding a contemporary viewpoint [18]. In a different manner to cultural heritage, these kinds of interventions could be favored by the existence of documentation pertaining to the original building or renovations [19], whose information ought to be analyzed by architects before the drafting of the intervention plans.

But the preservation of these buildings should not only go over a direct intervention. Just as in cultural heritage, knowing the vulnerability of these buildings and the hazards to which they are exposed, allows us to establish a risk evaluation. The first approaches towards this matter have been made from two distinct points of view. On one hand, through the evaluation of contemporary materials' resistance towards certain risks, such as durability of concrete reinforcements towards earthquakes [20], and on the other hand, through the inclusion of contemporary buildings in risk and vulnerability studies geared towards heritage, such as the studies about seismic risks for the monumental set of the city of Thessaloniki (Greece) [21]. These types of studies require the adaptation of techniques usually employed for the diagnostic of historical buildings, being adapted to the new architectural context [19]. For these reasons, in this paper is presented a new approach based on the vulnerability index for risk analysis of contemporary artworks, considering the environmental factors and the state of preservation of the building.

2. MATERIALS AND METHODS

2.1 Case of study

The National Schools of Arts (Cubanacán) is located in La Habana (Cuba) (figure 1). The set of buildings conforming the University of Arts (High Institute of Art, ISA), and the High School Level (Medium Level) of Music and Dance that constitutes one of the most outstanding examples of contemporary Cuban architecture, with an acknowledged artistic value.

Ricardo Porro Hidalgo (Cuba,1925-2014) designed the National School of Plastic Arts (where today lies the Faculty of Visual Arts) and the National School of Dance; Victorio Garatti (Italia, 1927) designed the National School of Ballet and the School of Music and Roberto Gottardi (Italia, 1927-2017) designed the National School of Drama, where today is the Faculty of Theatrical Art, in restoration plan in collaboration with Italian institutions. Those are the five schools known as National Schools of Arts (Cubanacán), which were declared National Monument of Cuba in 2010, and have been included in the attempt list of the World Heritage in 2003, 2005 and 2010.

The natural environment in which it is inserted encourages the artistic creation of the young talents that perform their work in buildings specially designed for the artistic teaching and practice.

Each construction included in the original project would receive a different artistic career; that's the reason for the unequal designs and therefore the stylistic variety of the ensemble.

Through the green color of the vegetation comes off the red of the bricks and the Catalan domes, the two essential constructive elements used for the architects in the Faculty of Plastic Arts by Ricardo Porro Hidalgo, the studied monument (*Fig. 1*).

Figure 1. *General view of Faculty of Plastic Arts by Ricardo Porro Hidalgo.*

The inner yards and the galleries that connect the modern and the traditional Cuban architecture, as well as the different forms that insinuates breasts, vaginas, fallopian tubes… all of them true signs of sensuality, are unique characteristics of this building (*Fig. 2*). Besides the value of the building, this institution supports an immaterial heritage, as some of the most representative artists of Cuban art have graduated in its classrooms.

Three domes are chosen for the study of vulnerability in order to develop a methodology that could be employed in the rest of the monument. *Table 1* summarizes the code and current use for each dome while figure 2 is a map of the building with the location of the three domes.

Table 1. *Domes of Faculty of Plastic Arts by Ricardo Porro Hidalgo chosen for the analysis*.

Code	Description and current use
Dome # 1	The largest dome is known as the Dome of Murals. At present this is the place in which the students of 2nd year of Art perform their artistic works. It also can be used as a display or exhibition area, or as a warehouse. It's like an artist's studio.
Dome # 2	This is the smaller dome, and serves as the painting professor's teaching department, as well as their workshop.
Dome # 3	With an intermedium size, this dome is the working place or workshop of the students of the last year of Art.

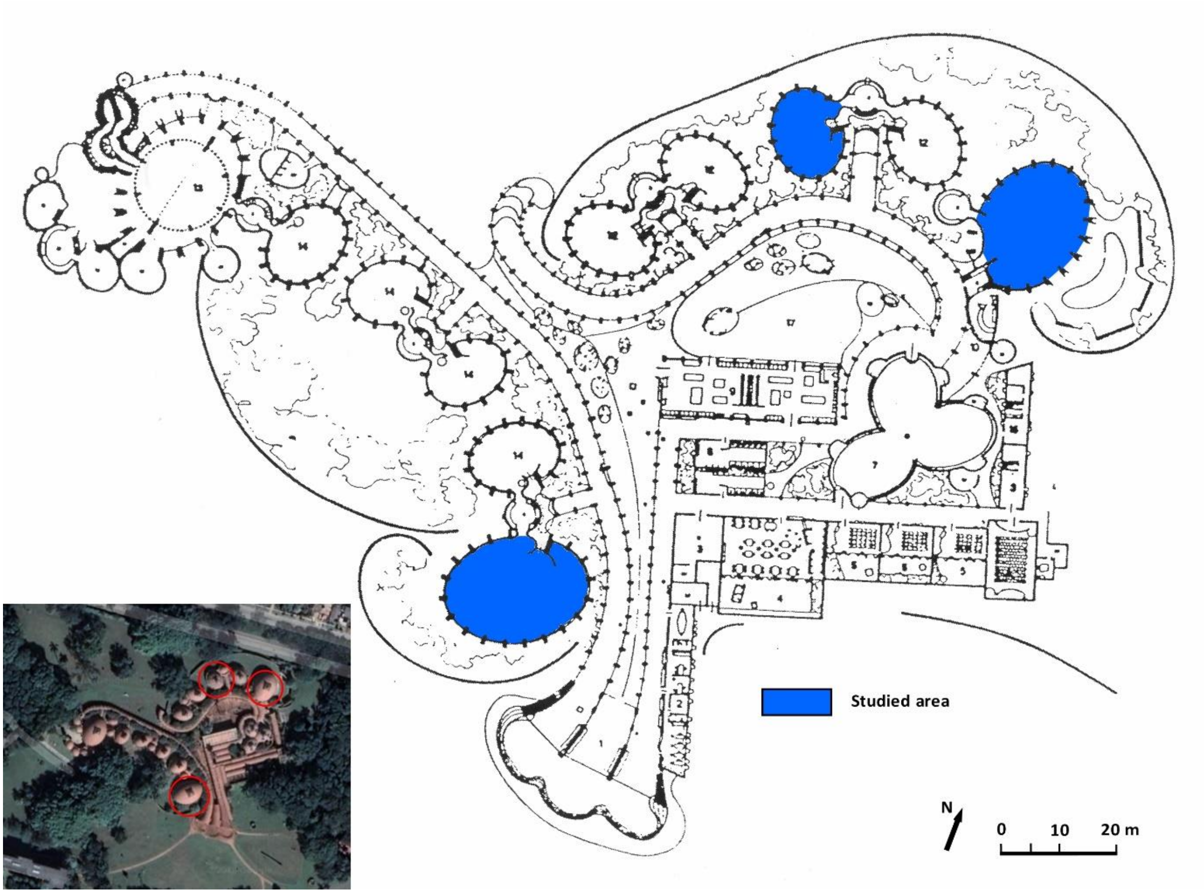

Figure 2. *Map of Faculty of Plastic Arts by Ricardo Porro Hidalgo with the location of the three domes in blue.*

2.2 Vulnerability index study

The degradation of building materials and structures is mainly due to deterioration caused by weathering and use, and conservation plans. Nevertheless, the constructive simplicity has an important role in the alteration process [22].

To determine the vulnerability index of each dome, the vulnerability index (VI%) and vulnerability expanded indexes were calculated, based on a vulnerability matrix (VM) according to the methodology developed by Ortiz and Ortiz [23], but adapted to suit the nature of this contemporary heritage to compare the three domes mentioned. The adaptation implies to consider the environmental conditions and the materials employed in this building, as a result, the vulnerability matrix recorded in *Table 2* has been developed.

Table 2. *Characterization of vulnerability matrix of domes at Faculty of Plastic Arts*

		Material			Structure				Anthropogenic factors	
		Physical - chemical characteristics	*Texture/ structure*	*Fire resistance*	*Foundation*	*Building structure*	*Construction*	*Building simplicity*	*Visual appearance*	*Urban planning protection*
Soil	*geo-technique*		frc,frag	frc,frag	frc,frag	frc,frag	frc,frag		frc,frag	
	underground water	e	am,ds,ar,ac,frc, fi,frag		frc,frag	ac,frc, frag	am,ds, ar,e,ac, frc,fi,frag		am,ds,ar,e,ac,frc, fi,frag	
Weather	*wind*		er, ar				er, ar		er, ar	
	temperature	e	am, ds, def, frc, fi,frag,ar,ds			frc, fi, frag	am, ds, e, def, frc, fi, frag, ar, ds		am, ds, e, def, frc, fi, frag, ar, ds	
	rain	cc	ac, er, ds, zl				ac, cc, er, ds,zl		cc, ac, er, ds, zl	
	dew	e	ac, am, ds, frc, fi,frag,er, ar				am, ds, e, frc, fi,frag, ac, er, ar		am, ds, e, frc, fi,frag, ac, er, ar	
Natural risks	*earthquakes*		pm, frc,frag	frc,frag	frc,frag	frc,frag	pm,frc, frag		pm,frc,frag	
Anthropic action	*tourist pressure*		er				er		Er	
	use/disuse		er, pm, ac, ex				er, pm, ac, ex		er, pm, ac, ex	
	fires		ac				ac		Ac	
	building work	i	i	frc,fi, frag	frc,frag,i	frc,frag,i	frc,fi, frag, i		frc,fi,frag,i	
	war		pm				pm		Pm	
	load		def			def	def		Def	
Pollution	*gases*	c					c		C	
	particles		d, pt				d, pt		d, pt	
Biological agents		g, b	v		v	V	g, b, v		g, b, v	
	vandalism (graffiti, ...)		ac, ex				ac, ex		ac, ex	

Monument security	*accesibility (theft, loss of material…)*		pm				pm		Pm	

FEATURES INDUCED BY MATERIAL LOSS: **pm**: missing part;**er:** erosion.
DISCOLORATION AND DEPOSIT: **ac:** colouration or discoloration and moist area; **zl:** soiling; **e:** efflorescence; **cc:** concretion; **pt:** patina; **d:** surface deposit; **c:** black crust; **g:** deposit of pigeon droppings
CRACK AND DEFORMATION: **def:** deformation **fi:** crack; **frc:** fracture; **frg**: fragmentation.
DETACHMENT: **ar:** sanding, **ex:** scratching; **dc:** scaling; **ds:** detachment;**am:** blistering
BIOLOGICAL COLONIZATION: **b:** biological colonization; **v:** plant.
OTHERS**:** **i:** building works

Each impact (matrix cell) is described with all the potential weathering forms that could be found in the domes of Faculty of Plastic Arts. Four experts of the school of Art carried out the in-situ inspection of weathering forms according to CNR-ICR Normal 1/88 [24], *Fitzner*[25] and the ICOMOS-ISCS glossary [26]. The domes where divided in five zones for the diagnosis: interior or north, south, east and west external walls. The vulnerability matrix was prepared by inserting the hazards of the domes in the rows and the building material characteristics, degree of structural conservation and anthropogenic factors in the columns of the adapted vulnerability matrix. These characteristics were included in a preliminary classification to obtain the vulnerability matrix.

According to *Ortiz&Ortiz*[23], an evaluation of the frequency of weathering forms was set between 1 and 3: (a) frequency 1: difficult to detect the presence of the weathering form, (b) frequency 2: weathering form identified easily and (c) frequency 3: high rate of occurrence, while the degree of weathering was classified into six relative categories adapting the categorization developed by *Fitzner*[25] for stones. Level 0 means no damage while levels 1 to 5 range from very low-level damage to very high damage. Frequency and damage level were combined as shown in *Table 3* to obtain a numerical value for the intensity of weathering forms in each monument.

After studying the weathering forms, the vulnerability index (*VI*) was calculated by dividing the total value of the deterioration patterns (*Vx*) for a monument by the sum of the total value of deterioration patterns in the worst case (*∑vdp*), when the frequency would be maximum *Ortiz et al.* [27]

$$VI = \frac{Vx}{\sum_{f=3} vdp} x100 \quad (1)$$

An expanded vulnerability index was developed according to a DELPHI assessment of the influence of different characteristics in the vulnerability matrix [23]:

$$\mathrm{VIe} = \sum \mathrm{fiVi} \quad (2)$$

where:

fi is associated weighting factor according to DELPHI forecasting

Vi is the vulnerability associated to the variable *i*

Finally, the expanded vulnerability index (*VI*%) was classified by degree of vulnerability using ordinal classes as described by *Galán et al.*[28] very low (<10%), low (10-25%), moderate (25-50%), high (50-75%) and very high vulnerability (>75%).

The results of the vulnerability index were validated by a blind trial, where three experts were consulted about the dome in better and worse condition of conservation.

3. RESULTS AND DISCUSSION

The predominant materials used in the monuments studied were bricks, mortars and a finishing consisting of ceramic tiles on roofs.

The main weathering forms found in the three domes were: (a) missing part and erosion, (b) coloration or discoloration, moist areas, soiling, efflorescence, concretion, surface deposit, black crust, and deposit of pigeon droppings, (c) deformation, crack, fracture and fragmentation, (d) sanding, scratching, scaling, detachment and blistering, (e) biological colonization and plant, (f) building works. Other patterns as loose of painting area, iron-rich patina, patina, differential erosion, pitting, alveolization and high alveolization common in other periods are not found in this monument due to the materials employed.

The most widely represented weathering forms found in the three domes were missing part, coloration or discoloration, scaling, moist areas, efflorescence, surface deposit, black crust and biological colonization (*Fig. 3*). Most of this damage is associated with the environment with high humidity and salts, which imply that the external agents that cause these conditions clearly affect the conservation of these domes. Efflorescence, black crust, surface deposits and biological colonization appear abundantly, and are associated with capillarity dampness, water percolation, biological environment, the use of incompatible materials and rainfall.

Despite the context, in a natural area, the presence of vegetation is not so abundant though it depends on the season.

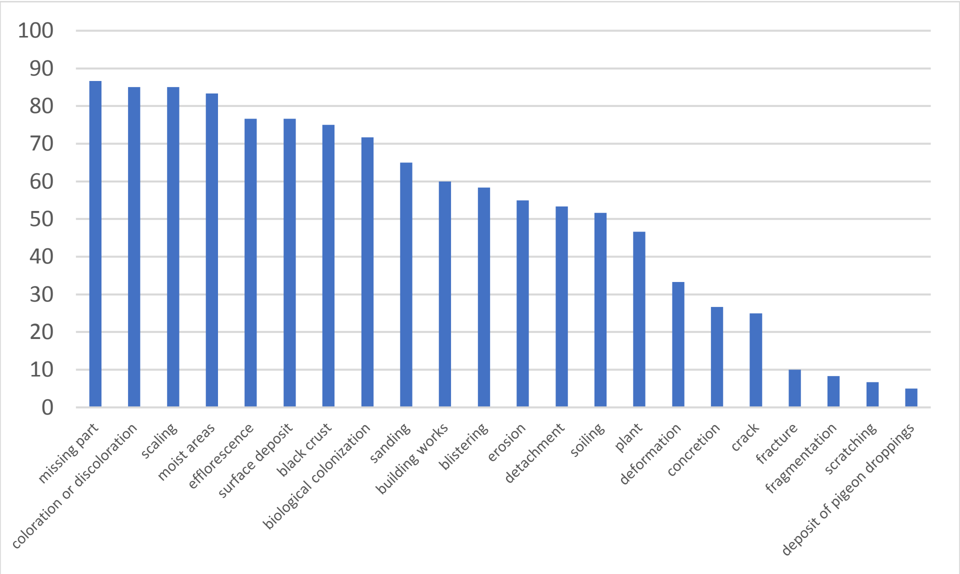

Figure 3. *Percentage of weathering forms found during the in-situ studies.*

The vulnerability index (*VI*%) and expanded vulnerability index (*VIe*) are shown in *Fig. 3*. The expanded vulnerability index (*VIe*) allows to weigh, those structural variables over aesthetic values or materials, and to consider level of usage, cataloguing and constructive simplicity. The three domes have the minimum vulnerability due to level of usage, as it is used every day as part of the classroom of the school of arts, meanwhile cataloguing is maximum due to the value of this masterpiece of Ricardo Porro, National Monument of Cuba. Constructive simplicity has been analyzed according to Macias [29], the three domes have a medium-high value (2.5-3) due to the laborious structure and Design of Ricardo Porro, but there are differences as dome

1 has more connections with other structures and galleries in the whole building, while dome 2 and 3 have less connections.

Results of vulnerability index and expanded vulnerability index are shown in figure 4. Currently, the dome 1 is the most vulnerable with a vulnerability index *Vi* average of 51%, that implies a high vulnerability according to the classification of *Galán et al.* [28], while the other two domes have a moderate vulnerability, 40% and 35%, respectively for Dome 2 and 3. These results imply that the state of conservation of Dome 1 makes it more vulnerable to extrinsic factors than the other monuments.

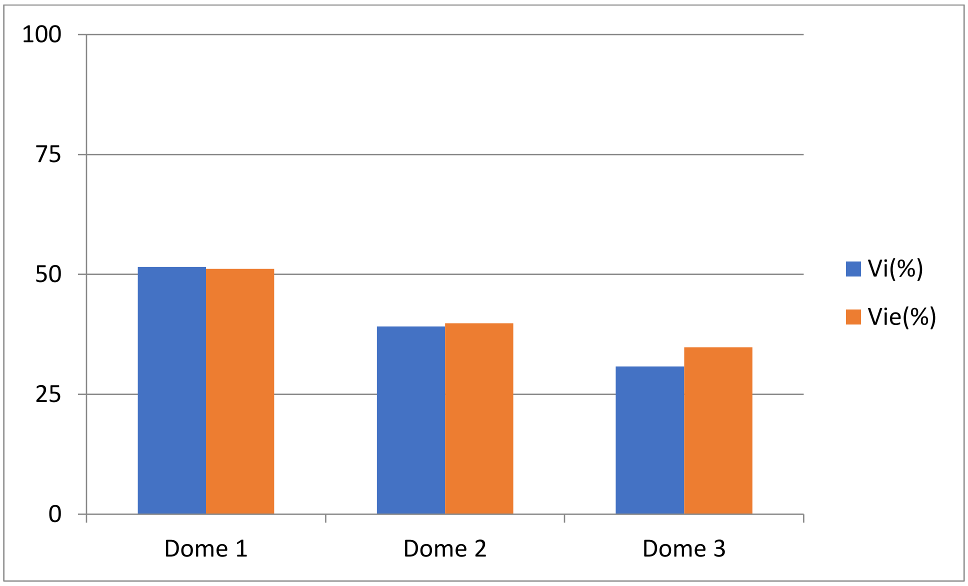

Figure 4. *Vulnerability Index and Expanded vulnerability index of the three domes.*

The blind trial was conducted by three experts who were asked about the dome in better and worse condition in their opinion, this diagnosis validated the results as the three experts agreed that dome 1 was is the worst conservation conditions. This traditional diagnosis conclude that Dome 1 has the best ventilation but the worst alterations due to appreciable detachment of the roof, abundant missing parts and chromatic alteration due to the alteration of bricks, efflorescence, black crusts, vegetation, and signs of previous intervention with apparently incompatible bricks (*Fig. 5*). These results are according with those obtained for vulnerability and vulnerability expanded index adapted for this contemporary art-work.

According to the experts, the dome that is in better condition externally is Dome 2. Dome 2 and 3 have a moderate vulnerability, 40% and 35%, respectively, those difference are not enough for human evaluation without a Delphi methodology as the developed in this work.

Figure 5. *Conservation state of Dome 1 with coloration or discoloration, missing part, moist areas, scaling and efflorescence.*

Priorities defined by ICCROM-CCI-ICN [30] for the conservation must consider the magnitude of risk and uncertainty. *Table 3* shows the valuation of the index of vulnerability combined with the feasibility and costs of risk reduction according to *Ortiz&Ortiz* [23], and include the magnitude of the vulnerability and the standard deviation data obtained from the experts´ opinions. Dome 1 with a high vulnerability and a high uncertainty (51%±17) must have a high priority for research with short-term mitigation strategy; it is recommended a cost-benefit analysis of the mitigation strategy. On the other hand, Dome 2 and 3 with moderate vulnerability (40% and 35%) and low uncertainty (Standard deviation: 6 and 3 respectively) must prioritize the mitigation strategies by cost-benefit analysis. Nevertheless, we must understand that in this analysis, three domes of the whole monuments have been compared due to the complexity of the whole monument. Further analysis must be taken into account to analyze the whole building and the relationships between the different domes with corridor and open spaces.

Moreover, for these domes with moderate and high vulnerability, a yearly monitoring and inspections is recommended to update the analysis.

Table 3. *Matrix of priority based on level of vulnerability and level of uncertainty*

		very low (<10%)	low (10-25%)	moderate (25-50%)	high (50-75%)	very high vulnerability
		Vulnerability				
UNCERTAINTY	*high*	Requires research to ascertain that assessment is correct, but low priority.	Apply low cost mitigation; cost-benefit analysis of research to reduce uncertainty when highest risks have been dealt with	High priority for research, cost-benefit analysis of the mitigation strategy is recommended	High priority for research; short-term mitigation strategy is recommended; cost-benefit analysis of the mitigation strategy is recommended **Dome 1, Vie**(51%±17)	Highest priority for research; short-term mitigation strategy will buy time until uncertainty is lower; cost-benefit analysis of the mitigation strategy is recommended.
	moderate	Low magnitude of risk with moderate uncertainty is acceptable. Action is not necessary.	No direct action required but try to reduce the uncertainty. Cost-benefit analysis of mitigation versus research.	Risk mitigation prioritized by cost-benefit analysis of research and further risk analysis	Risk mitigation prioritized by cost-benefit analysis of mitigation strategies, research and further risk analysis.	Second priority risk mitigation. Cost-benefit analysis of mitigation strategies and research is recommended.
	low	Low magnitude of risk with low uncertainty is acceptable. No action.	Mitigate risk when highest risks have been dealt with, based on cost-benefit analysis of mitigation strategies.	Prioritize by cost-benefit analysis of mitigation strategies. **Dome 2 Vie** (40%±5) **Dome 3 Vie** (35%±2)	High priority for risk mitigation	Highest priority for risk mitigation

Source: based on ICCROM–CCI–ICN (2007) for risk and uncertainty [30]

4. CONCLUSIONS

This paper presents the application of a new tool based on vulnerability in buildings to three domes of the Faculty of Visual Arts (Cubanacán, La Habana, Cuba), a masterpiece of Ricardo Porro Hidalgo in order to develop conservation strategies that can minimize risk of damage and reduce the cost of isolated interventions. The vulnerability study involves an on-site diagnosis analysis and requires an adapted protocol for contemporary art-works.

In this study, the monument has different levels of conservation that range from moderate to highly vulnerable. The most vulnerable dome studied is Dome 1, which is highly vulnerable due to appreciable detachment of the roof, abundant missing parts and chromatic alteration due to the alteration of bricks, or efflorescence, black crusts, vegetation, and signs of previous intervention with apparently incompatible bricks, while the other two domes show moderate vulnerability.

The novelty of this approach is a multidisciplinary approach that includes the analysis of vulnerability in contemporary architectural heritage and the analysis of environmental factors around the monuments. Further studies are recommended to improve the methodology to study the whole monument and the complexity of the relationships between the domes, corridor and landscape.

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