

## The blue domes of Valencia: the challenge of their digitisation

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### Abstract

*The blue domes are perhaps the architectural element that best defines Valencian architecture. These structures, present in numerous historic and religious buildings, beautify the urban landscape and represent the region's rich cultural and artistic heritage. However, despite their importance, no clear strategic plan exists for their enhancement and conservation.*

*Creating a specialised digital repository for the blue domes of Valencia is an urgent necessity. This repository should include a comprehensive typological classification, documenting each dome's architectural and stylistic characteristics. Advanced technologies such as 3D scanning and photogrammetry can capture and store precise details of these structures. The HBIM methodology can be beneficial, allowing for the integration of detailed data on each dome's construction, materials, and conservation status.*

*A well-organised repository would not only facilitate better heritage management but could also be linked to cultural tourism. Valencia has great potential to attract tourists interested in architecture and history. Promoting tourist routes centred on the blue domes can increase the visibility and cultural value of these elements. Furthermore, the repository could be vital for academic and professional research. Researchers, art historians, and architects would have access to a complete and detailed database, facilitating studies and conservation projects.*

**Keywords:** HBIM, dome, repository, evaluation, digitisation.

## 1. Introduction

As a result of various heritage restoration interventions on domes carried out in recent years, a lack of documentation and technical information has been identified as a prior need for their study or intervention, such as architectural surveys, construction dates, typology, materials and techniques used, etc. This situation has become particularly evident in emergency and/or urgent interventions, where action has had to be immediate.

Although we could determine that domes originate from Eastern construction (Patetta, 1984), blue domes are the DNA of Valencian architecture, especially from the Renaissance and for more than four centuries up to the 20th century, when the Industrial Revolution introduced other materials, such as concrete and steel. The domes are not only a visual aspect—many remain landmarks of the urban landscape and the skyline of many Valencian towns—but also form a constructive artefact demonstrating the mastery of a centuries-old construction tradition. Specialists in structures, architecture, and construction have admired these domes. It is difficult to establish an ordered category regarding their typologies, as each restoration uncovers surprising data, such as brickwork, construction arrangement, brick sizes, etc.



**Figure 1.** A partial image of the 1786 ceramic panel of Our Lady of Consolation on the façade of the Church of Saint Thomas and Saint Philip Neri in Valencia depicts two domes in the skyline of a walled town. Source: Cortés, L. (2016).

In this sense, innovative studies emerge on significant domes such as Santa Maria del Fiore (Fanelli, 2022) and the Pantheon (Masi, 2018). Although heritage preservation means conservation and restoration, the Valencian heritage law provides the legal framework for conserving, disseminating, promoting, and enhancing cultural heritage within the territorial scope. There is no doubt that the blue domes of Valencia are a hallmark of the Valencian people and a testament to their contribution to culture; not only the Valencian domes but domes, in general, are a universal heritage. Remember that in the logo of the prestigious entity Europa Nostra, we can see the silhouette of a dome in the centre.

This is why a scientific initiative is being launched to highlight the value of the Valencian domes, characterised by the blue of their tiles, with the main focus being their digitisation to establish a comprehensive catalogue.

## 2. Objectives

The main objective of this communication is to highlight the value of Valencian domes through an initial protocol for their digitisation and integration into cultural use, such as tourism. This initiative aims to generate positive impacts for the monuments and/or communities hosting domes. Promoting cultural tourism can stimulate job

creation and wealth, especially in smaller communities facing depopulation due to low birth rates and youth emigration seeking opportunities.

As the digitisation of the domes progresses, information can be collected in an accessible repository for tourist use, either through websites or by installing informative signs in the monuments, accompanied by QR codes to provide additional information to interested visitors. In this sense, it is understood that digitisation and sustainability are closely linked in the pursuit of more efficient and responsible development. However, further research is needed to adequately address this aspect, representing a proposed research direction.

Additionally, issues related to training specialised personnel and preserving these construction techniques and architectural typologies are raised. This could include organising specialised seminars or workshops and integrating these topics into vocational training programs or university degrees in Architecture and Technical Architecture.

### **3. Object of study**

Domes in Valencia began to be constructed during the Renaissance, following the Council of Trent (1545-1563), with the first being the dome of the Church of Corpus Christi (1595). However, the heyday of domes in Valencian architecture occurred in the 17th and 18th centuries, adorning numerous churches and civic buildings. These domes were primarily built in new chapels dedicated to the adoration of the Sacrament, with a centralised plan located on one side of the existing Gothic churches, which were being renovated with a new coating to suit the period's aesthetics.

With its oval dome, the Basilica of Our Lady of the Forsaken symbolises Valencian Baroque. The dome reached its largest possible dimension in 1770 with the construction of the Church of the Pious Schools, 24.5 metres, within the prestigious group of great European domes. The Royal Academy of Fine Arts of San Carlos holds many designs from the last third of the 18th century (Soler, 2017). The dome of the Central Market, built in the early 20th century, reflects Valencian Modernism and its ability to fuse tradition and innovation, with Rafael Guastavino being the foremost exporter of this tradition to North America in the 20th century. Although hundreds of domes that could be cited as Valencian still stand, there was a period of fear of building them due to many documented collapses during the 18th century (Gil, 2015).

Domes in Valencia represent several significant aspects of the culture and history of the entire Valencian territory:

- a) **Wealth and power:** Domes, especially in religious and civic buildings, symbolise the wealth and power of the institutions that built them. Their majesty and ornamentation reflect the prosperity of Valencia in different eras.
- b) **Architectural development:** The presence of domes in many historical buildings shows the architectural evolution of Valencia from the Renaissance to Modernism. Each dome reflects the trends and construction techniques of its time.
- c) **Cultural heritage:** Domes are integral to Valencian cultural heritage. Buildings such as the Basilica of Our Lady of the Forsaken and the Church of the Pious Schools stand out for their domes and are essential landmarks for locals and tourists.
- d) **Spirituality and religion:** In churches, domes symbolise the connection between heaven and earth, representing a sacred space and elevating the spirituality of the faithful.



**Figure 2.** The dome of the Church of the Pious Schools of Valencia during its restoration in 2024. Source: Cortés, L. (2024)

#### **4. Methodology and Procedure**

When discussing cataloguing, we find ourselves in a situation comparable to standing at the edge of a well. Initially, the full extent of the issue is unknown. The task of cataloguing involves facing uncertainty regarding the quantity, diversity, and complexity of the elements to be classified. It is a process that can reveal unknown depth and breadth in its early stages, requiring patience, organisation, and a methodical approach to adequately explore and document all available content.

In this case, cataloguing inherently includes digitisation; digitising to preserve originality is essential. Originality is maintained because, in a restoration or repair project, the original appearance can be restored by having control over its shape and typology. This is especially important in disasters where collapse or significant damage may require reconstruction. Digitisation provides a detailed and precise record of the original state of objects, allowing any future restoration or reconstruction to be carried out with an exact reference, thus ensuring the integrity and authenticity of cultural heritage. An example is the dome of the Church of Sales in Sueca, which has already had six different domes in just 250 years since its founding (Cortés, 2024).

Carrying out cataloguing with its corresponding digitisation depends on several factors, primarily economic factors. This process can be developed through a research project, doctoral thesis, or professional cataloguing work, requiring institutional (political) support in the latter case. Similarly, as in the 1980s when the Conselleria de Cultura of the Generalitat Valenciana commissioned a comprehensive study of monuments to create the Catalogue of Monuments (Bérchez, 1983) after the competencies were transferred to the autonomous communities, a catalogue of domes can be proposed. Another idea, following the collapses of the domes of Crist de Benigànim, Sumacarcet, Sueca, and Massamagrell, or the vault of the Church of Sollana, is for the Administration to formalise a Dome Evaluation Report, similar to the existing one for houses over 50 years old.

Although we are currently at the beginning of a long process and there is no ongoing research apart from articles in research journals, a working methodology is proposed that addresses the scientific documentation of the domes and cultural awareness.

On 13th March 2023, the proposal to introduce the Valencian blue domes as UNESCO World Heritage was initially presented to the national deputy for Valencia, the Most Excellent Mrs Alma Alfonso, in the Congress of Deputies (Madrid). Valuing these highly significant structures, vestiges of the knowledge and construction tradition of Valencian masters will serve as the foundation for the entire process.



**Figure 3.** Submission of the proposal for including the Valencian domes as UNESCO World Heritage by Luis Cortés to the Most Excellent Mrs Alma Alfonso at the Congress of Deputies, Madrid (Spain). Source: Cortés, L. (2024)

The study methodology is initially defined based on the intervention in the largest Valencian dome, which, if we're talking about ceramic tile roofing systems, would be the largest in Spain, funded by the Spanish government through a direct grant.

Regardless of the historical study, the first task would be graphic surveying, which must be approached with precision and state-of-the-art technology such as 3D laser scanning (TLS). The main advantage of this method is that it allows us to obtain a point cloud to represent the virtual dome in three dimensions, with a registration accuracy ranging from 1 to 2 mm. This system facilitates data collection on thickness, shape, curvatures, collapses or other defects, the number of tiles, and even an initial assessment of pathologies in its coating (García, 2024).

Taking photographs with cameras and aerial images with drones is complementary and necessary for optimal graphic representation. Ground-level photographs capture details and textures, while aerial images provide an overall view and a unique perspective of the domes. This combination of techniques ensures complete and accurate documentation, facilitating cataloguing, research, and restoration work. Drone technology, in particular, allows access to angles and heights that are difficult to reach, significantly improving the quality and comprehensiveness of the visual record of architectural heritage.

An intermediate phase would be creating the HBIM (Heritage Building Information Modelling) model, where 3D modelling is generated, and data from laser scanning and photogrammetry are incorporated into the model.

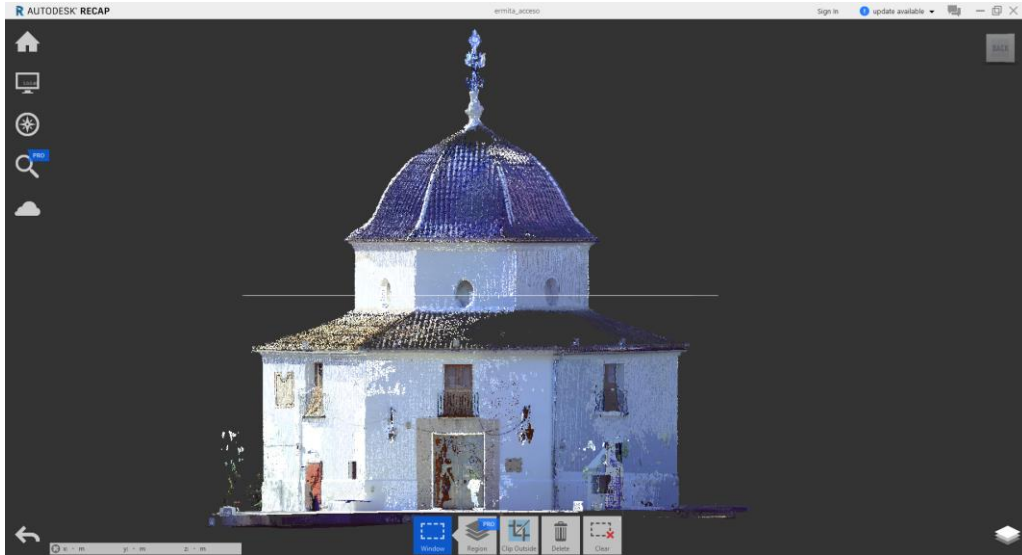


Figure 4. Point cloud modelling of the Sant Bernat de Carlet dome in the Autodesk® ReCap® Pro program.

From the pathological study, based on the graphic survey, the following aspects can be determined:

1. Conservation Status: Identify deteriorated areas, cracks, detachments, and other structural damages.
2. Materials and Construction Techniques: Analyse the original materials and construction techniques employed.
3. Causes of Deterioration: Determine the underlying causes of the damages, such as moisture, pollution, or structural movements.
4. Previous Interventions: Detect and evaluate previous restorations, their quality, and their impact on the structure.
5. Restoration Plan: Develop an appropriate and specific intervention plan for the structure's needs, ensuring its stability and future preservation.

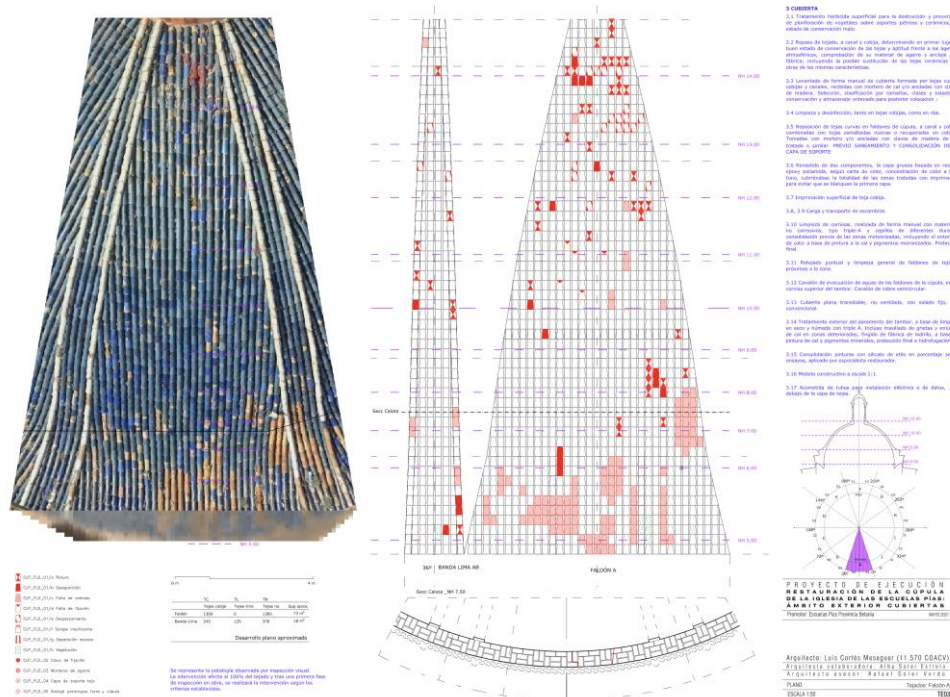


Figure 5. Pathological study of the execution project in the Church of the Escuelas Pías in Valencia. Source: Cortés, L. (2022)

This comprehensive approach allows for informed and precise decision-making regarding the conservation and restoration of architectural heritage and the management of budget and project execution, thereby avoiding unfortunate interventions with improper materials or techniques. Additionally, it provides an initial assessment of the dome's originality and identifies any significant repairs at first glance. It's worth noting that determining its construction material can be complex without the necessary core samples.

Following the initial steps of digitisation and pathological study, including structural and built artefact analysis, the classification of domes can be determined based on various parameters:

- *Number of layers*: It can be single or double, with the latter having an air chamber.
- *Construction technique*: tabicada (tiled) or aparejada (brickwork), with tabicada being thinner than aparejada.
- *Type of tile*: curved ceramic, fish scale, or Roman tile.
- *Construction date*: crucial for understanding the technology used.
- *Authorship*: requires collaboration with specialists to attempt identification.
- *Shape of the drum's floor plan*: can be circular, octagonal, or even heptagonal in cases like the hermitages of Nules and Carlet.
- *Number of dome sides*.
- *Shape of the dome*: hemispherical, parabolic, etc.
- *Architectural style*: likely Baroque or Neoclassical, possibly with Renaissance influences.
- *Presence of lantern*: If absent, there's usually a stone top with a metal cross and/or weather vane.
- *Tile colour*: natural brown and green, though blue-glazed tile is characteristic.

This classification can be further subdivided according to Soler's tabicada construction type (Soler, 2015), which includes categories such as "trasdosadas" (backed) or "sin trasdosar" (without backing), with various subtypes for single and double-layer constructions.

Consideration should be given to creating a repository connected with local administrations and the General Directorate of Heritage of the Valencian Government, documenting all restoration interventions on the domes. This would gradually increase the number of cases studied and their classification.

Furthermore, this study facilitates the planning of future interventions for building conservation and restoration and the generation of detailed documentation and management of information related to future projects through Building Information Modeling (BIM). The application of BIM in the conservation of architectural heritage improves the accuracy and efficiency of restoration projects and ensures more sustainable and effective long-term management.

## 5. Results

The main results have arisen from recent architectural interventions in domes, revealing a significant lack of maintenance in buildings and, therefore, in their heritage assessment. On the other hand, publications and press articles highlight the importance of preserving architectural heritage. These communications raise awareness and educate the public about the historical and cultural value of buildings and restoration efforts. Media coverage helps generate social, economic, and political support, which is essential for conservation projects. Additionally, it promotes civic participation and recognition of heritage as an integral part of a community's identity and collective memory.



**Figure 6.** The Dome of the Church of Massamagrell was built in 1953 and restored in 2022. Source: Cortés L. (2024)

After presenting the intervention project with the proposed study methodology to the Ministry of Development in 2020, the Spanish Government, included in the General State Budget for 2022, is funding the restoration of the largest Valencian dome with an amount of one million four hundred thousand euros.

The national deputy, Mr Borja Sémpér, is responsible for managing the proposal to include the blue domes on the UNESCO World Heritage List, which will require reports from various prestigious institutions such as Docomomo to support its presentation.

Another result of this knowledge process is precisely the opposite of the approach to the preservation study of Valencian domes; the construction material has been reversed because the finishing material was not suitable for its structure. An example is the Sales church, whose dome was built in 1898 with a metal structure and a zinc sheet covering. In 1919, it was rebuilt using the same metal structure, but an outer layer of brickwork and blue fish scale tiles was added. However, a defective construction joint was found at the eaves, allowing water to enter the interior. The resulting condensation favoured the oxidation and corrosion of the reinforcement, generating solid tensions in the structure and breaking the blue tiles, which were in a completely vertical position. Other design errors also influenced the decision to replace the masonry arrangement with ceramic tiles with a lighter one made of Tecu (oxidised copper), reducing the weight from 60 to 6 tons (Cortés, 2024).





**Figure 7.** Based on the study methodology, the dome of the Sales church in Sueca was reconstructed.  
Source: Cortés, L. (2022)

## 6. Conclusions

The domes are the DNA of the masonry construction tradition deeply rooted in Valencia after the Gothic era, and they should be valued, not only through dissemination in books.

Recent interventions following partial collapses highlight the need to undertake conservation studies to prevent future collapses that could result in tragedies. These studies should adopt a standardised methodology to unify criteria as part of a protocol.

Having a documentary and graphic repository of the domes enables the responsible technician to know what they are dealing with in emergencies, avoiding delays in the preliminary study process for project drafting. Additionally, in cases of existing pathological injuries that could cause partial collapse or deterioration, it can serve as a demonstration to society for their conservation. It could be used for crowdfunding or financial support.

The conclusion would be to propose future lines of research to undertake more exhaustive studies and compare them with other domes worldwide.

## 7. References

- Cortés Meseguer, L. (2016). La Ribera Baixa. La Diputació Provincial de València i el patrimoni cultural. Quinze anys d'història. 1 una mirada al patrimoni. Excellentíssima Diputació Provincial de València. Diputació de València.
- Cortés Meseguer, L. & Pardo-Conejero, J. (2024). Un tejado moderno para la cúpula de la iglesia de Sales. *Informes de la Construcción*, 76(573): 6470. <https://doi.org/10.3989/ic.6470>
- Fanelli, G. & Fanelli, M. (2022). La cúpula de Brunelleschi. Historia y futuro de una grande estructura. Florence: Mandragora.
- García Valldecabres, J., Escudero, P.A., López González, M.C. & Cortés Meseguer, L. (2024). Optimización del registro de lesiones constructivas a través de la metodología Scan-to-BIM. In *Congreso EUBIM 2024*. Universitat Politècnica de València.
- Gil Saura, Y. (2015). El miedo a levantar las cúpulas en la arquitectura valenciana del siglo XVIII: los tambores. In Piazza, S. (Ed.), *Saperi a confronto. Consulte e perizie sulle criticità strutturali dell'architettura d'età moderna (XV-XVIII secolo)*. Palermo: Caracol
- Masi, F., Stefanou, I. & Vanucci, P. (2018). On the origin of the cracks in the dome of the Pantheon in Rome. Hal. <https://hal.archives-ouvertes.fr/hal-01719997v2>

- Patetta, L. (1984). *Historia de la Arquitectura. Antología crítica*. Madrid : Hermann Blume.
- Soler-Verdú, R. & Soler-Estrela, A. (2015). Tipología de cúpulas tabicadas. Geometría y construcción en la Valencia del siglo XVIII. *Informes de La Construcción*, 67(538), e078. <https://doi.org/10.3989/ic.13.180>
- Soler, R., Martínez, A. & Alonso, A. (2006). The eighteenth-century brickwork domes in Valencia. En Dunkeld, M., Campbell, J., Louw, H., Tutton, M., Addis, B., Thorne, R. (Eds.), *Proceedings of The second International Congress on Construction History*, Vol. 3 (pp. 2945-2963). Cambridge: Construction History Society.
- Soler Verdú, R., Soler Estrela, A., & Cortes Meseguer, L. (2017). Tipología de cúpulas. Estudio de los proyectos académicos de la Real Academia de BB. AA. de San Carlos de Valencia. España. 1768-1846. In S. Huerta Fernández, P. Fuentes González, & I. J. Gil Crespo (Eds.), *Actas del Décimo Congreso Nacional y Segundo Congreso Internacional Hispanoamericano de Historia de la Construcción: Donostia-San Sebastián*, Vol. 3 (pp. 1583–1592). <https://dialnet.unirioja.es/servlet/articulo?codigo=7332285>