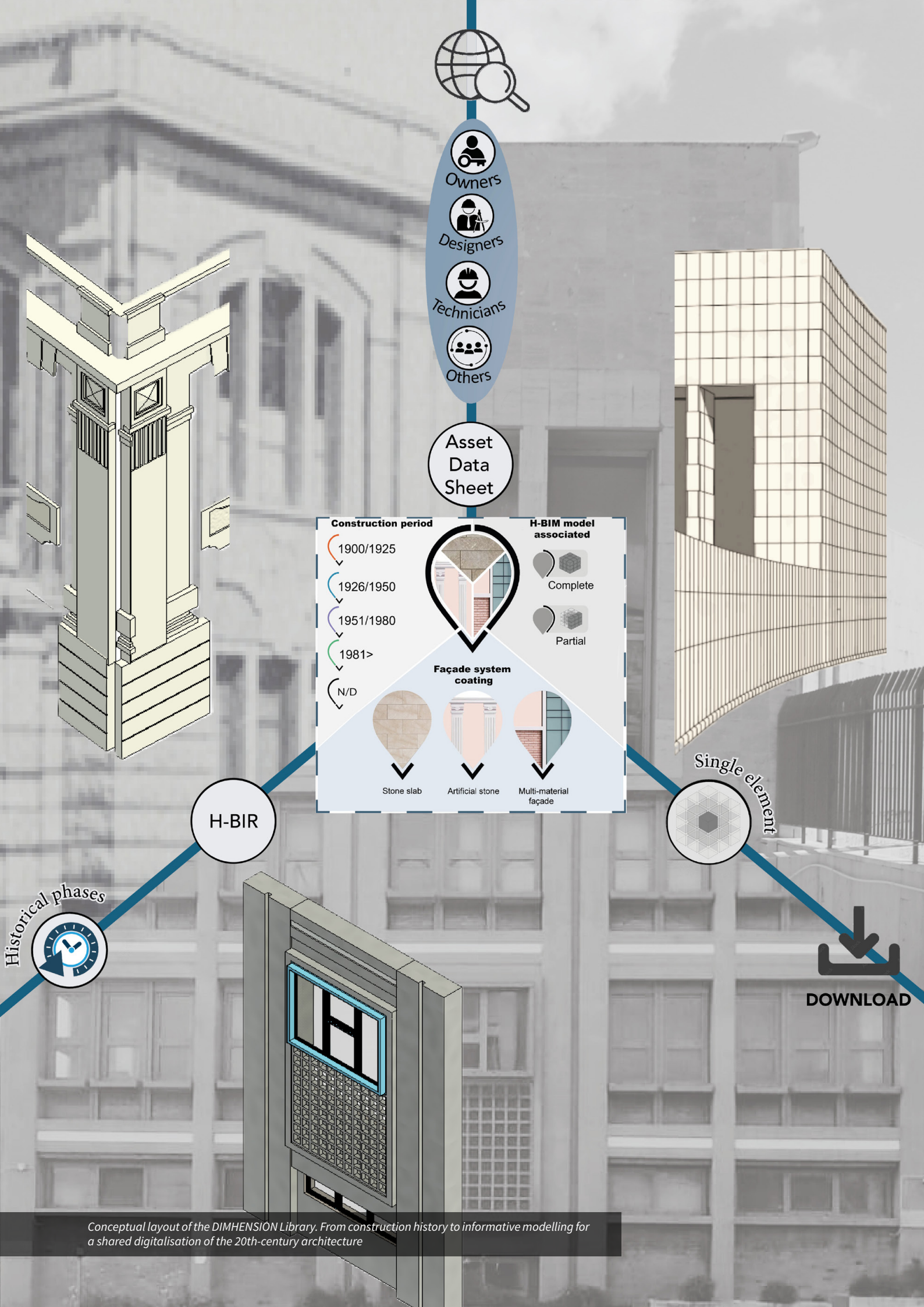

Conceptual layout of the DIMHENSION Library. From construction history to informative modelling for a shared digitalisation of the 20th-century architecture

The DIMHENSION Library. A web platform for 20th-century architecture

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Abstract: The analysis of tools for the digital consultation of cultural heritage has highlighted the need for a dynamic approach between the architectural asset and digital knowledge, in order to promote conservation, restoration, enhancement, and communication actions. Within the framework of the PRIN 2022 – DIMHENSION project (DIgital twin and Modern HEritage modelliNg towards Sustainable InfOrmed maNagement), the collaborative platform DIMHENSION Library was developed, capable of facilitating interaction between the cataloging of 20th-century works, the H-BIR digital repository and H-BIM. In this way, users can interactively engage with the history of the construction, technical and construction aspects, and the parametric model of the recorded architecture. For the development of the web platform, which brings together multidisciplinary skills, a methodological approach traceable to LOIN – Level of Information Need – was adopted, with the aim of establishing a structured and dynamic relationship between the Real Twin and Digital Twin models. This approach allows the methodology and framework to be reproducible, not only in the twentieth century but across different historical periods of architecture, from antiquity to the contemporary era, without the need for code refactoring.

Keywords: Digital Cultural Heritage; Technical-constructive elements; 20th-century Architecture; H-BIM; H-BIR.

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1. Introduction: the need for a platform to explore 20th-century architecture

A review of digital transition strategies aimed at cultural heritage, even when limiting the research scope to the Italian context, highlights how the field of investigation is vast and often fragmented (Allegrezza, 2021). In summary, it is possible to identify lines of action directly attributable to the MiC (Ministry of Culture),[1] others promoted by cultural associations and[2] some developed within the academic sphere.[3]

In the latter sector, the establishment of specific laboratories within universities dedicated to Digital Cultural Heritage has directly and explicitly highlighted the need to explore possible integrations between cultural heritage and digital technologies. It is not a matter of making bibliographic, archival and iconographic sources, as well as audio, video and digital materials, freely available, but of going further.

In fact, the strategic vision for the digital transition has been interpreted through the experimentation of innovative methods and tools for a more dynamic and effective approach to cultural heritage, preparatory to conservation, restoration, enhancement and communication actions. The developed activities (3D modelling and virtual restoration; 3D printing; virtual and augmented reality, VR/AR; digital repositories; historical and thematic GIS - Geographic Information System; interactive and web maps) allow for a meta-disciplinary approach that combines the rigour of scientific documentation with open dissemination for public and shared use.

Looking at the evolving virtual landscape and attempting to grasp its strategic vision, structural aspects and operational objectives, a methodological approach has tested to understand and fill the gaps identified (data fragmentation, centralised governance, cataloguing logic, lack of common standards, sustainability over time).

As part of the objectives of the PRIN 2022 Project that is entitled DIMHENSION (DIgital twin and Modern HEritage modelliNg towards Sustainable InfOrmed maNagement), a research group from the Laboratorio di Studi doCme 1908 (Documentation Centre for Messina) at the Department of Engineering – UniME conceived a collaborative platform to share knowledge of the historical architectural heritage of the 20th-century with a technical-construction approach; although the focus is currently mainly on façade systems, the platform has been designed for all construction elements of a building.

This paper presents the DIMHENSION Library, an original platform set up to support a digital catalogue of 20th-century works with a H-BIR (Historic – Building Information Repository) section, to collect all available sources in order to trace the history of construction, and a H-BIM (Historic – Building Information Modelling) section, to share total and partial models or objects that can be consulted and downloaded in template form and adopted to digitalise other buildings with similar features.

Its logic aims to overcome descriptive archiving in favour of informative synergy, addressing fragmentation and hyperspecialisation to enable shared knowledge and use of digital information.

2. State of art: the online search for Cultural Heritage digital content

To understand the development of digital content consistent with the objectives of the research undertaken, which aims to promote knowledge of 20th-century built heritage in its various aspects—formal, functional, technical, and pathological—it is necessary to navigate this virtual landscape by identifying thematic macro-categories that can support the selection of coherent content.

A distinction that encompasses the range of initiatives currently available—albeit still in a nascent stage—may be articulated as follows:

- creation of digital libraries, online archives, and cataloging of emblematic works and sites (Farroni and Faienza, 2024; ICCU, 2025);
- development of 3D reconstructions of sites, works, and objects, also with BIM (Building Information Modelling) approaches (Einaudi et al., 2020; Aburamadan et al., 2022; Daniels and Georgopoulos, 2023);[4]
- production of interactive narratives using multimedia elements (Pizzo et al., 2023).

The first section is currently the most advanced, as its structure has been addressed by a greater number of stakeholders since the 1990s.

These originally involved digitalisation projects applied to paper materials (bibliographic and archival sources) that were made available for online consultation. A further stage in this digital transition, emerging in the late 1990s, involved the standardised processing of information in catalogues of cards on 20th-century works according to shared regulatory criteria. More recent developments have been directed towards museums, archives,

libraries, central institutes, and state cultural heritage sites that own, safeguard, manage, and promote cultural assets, with the aim of creating interoperable databases accessible through dedicated platforms.

In this scenario, the Digital Library of the MiC (MiC, 2023) may be cited as a significant example, as it is grounded in an overarching strategic vision intended to integrate and systematise all digital content currently dispersed across separate repositories, both internal to the institution[5] and, from a broader, global perspective, external as well[6] (Figure 1).

The second section, through 3D modelling of historical sites, monuments and parts thereof, aims to offer a detailed and interactive representation of the environmental heritage.

In recent years (2020-2025), specific laboratories have been set up in academia with a view to developing the spectrum ranging from 3D modelling to digital dissemination through VR/AR and interactive storytelling, thus also covering part of the third section.

Three may be identified, differing only marginally in their perspectives and approaches: Digital Cultural Heritage at the Department of Cultural Heritage of the University of Padua, Digital Heritage at the Department of Cultural Heritage of the University of Bologna, and the interdepartmental laboratory of the Polytechnic University of Marche, dHeKalos LAB (Digital Heritage and Landscape Ecosystem).[7] The shared goal is to offer a service for the digital transition of cultural heritage, as also introduced by the Digital Library of the National Digitisation Plan (MiC, 2023). The results are interesting but still individual and do not amount to a technological infrastructure capable of bringing together existing and future DCHs as strategic nodes related to each other in terms of scientific expertise, technological equipment, experience and good practices, methodologies and research results.

The most versatile of the three in terms of the objectives of the DIMHENSION Library is the dHeKalos Lab, formed by the following research groups: Digital Cultural Heritage (DISTORI HERITAGE); Geomatics Applications & Processing (GAP); Vision, Robotics and Artificial Intelligence (VRAI), to offer complementary digitisation chains relating to the knowledge, conservation and enhancement of cultural, historical, architectural, urban and territorial heritage, to the creation of 3D models (2D/3D facsimiles), to the processing of geospatial data to monitor the territory and landscape, and the application of XS and Artificial Intelligence. In the DISTORI Lab portfolio (https://distori.org/portfolio), under the heading “digital architecture”, a wide range of historical architecture is presented, including some of the following non-navigable options: laser scanner and/or photogrammetric surveys, H-BIM modelling, digital documentation and diagnostic surveys, reconstructions and virtual tours (Figure 2). Only in the field of digital archaeology for the Marcheology portal there is a library of digital objects (https://www.marcheology.it/).

Figure 1 | MiC action lines.

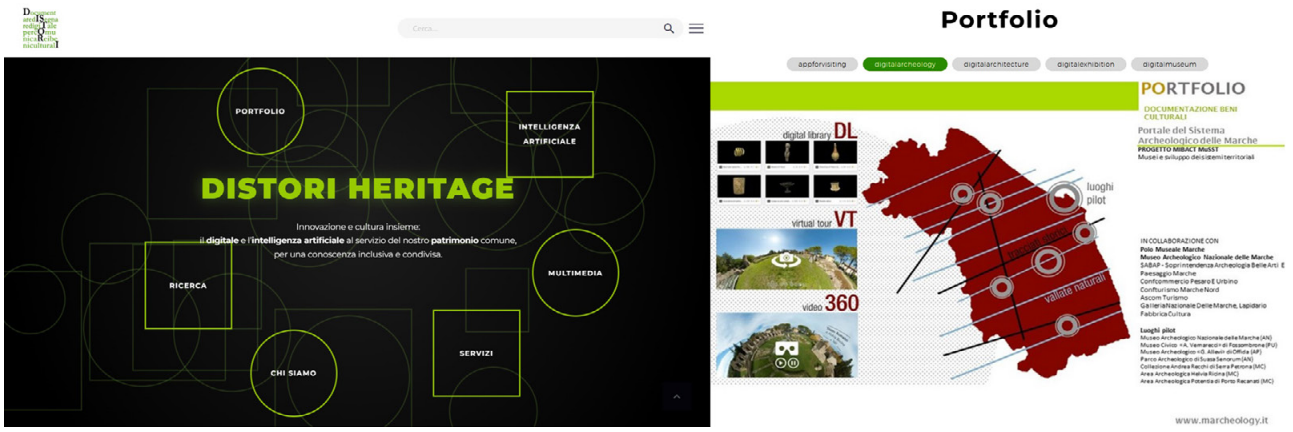


Figure 2 | The digital contents of DISTORI Lab.

The third section focuses on the development of platforms that, over the past decade, have enabled access to virtual exhibitions, guided tours, and digital restoration projects (Virtual Reality, Augmented Reality, Social Web, Digital Storytelling). A significant opportunity to assess the level of development of the dialogue between cultural heritage and digital technologies, as well as to explore communication languages and technologies, was provided by the international event Digital Heritage 2025, held in Siena from 8th to 13th September (UniSi, digitalheritage2025.unisi.it/).

Within this context, alongside the presentation and discussion of research project outcomes, best practices, and technological innovation, particular attention was devoted to the Digital Heritage Expo 2025 (UniSI, digitalheritage2025.unisi.it/expo/), an international exhibition dedicated to digital innovation applied to cultural heritage. Furthermore, a critical evaluation was conducted in the following areas:

- virtual (VR), augmented (AR), and extended reality (XR);
- 3D printing, holography and digital publishing;
- tools for restoration, digitisation and interactive storytelling;
- applications for museums, archives and libraries;
- immersive experiences and interdisciplinary projects.

By combining the principles underlying the three sections, the challenge undertaken has been to develop a platform that brings together an exhaustive cataloguing of each asset with knowledge of its history—accessible through the first section described—and a partial or complete parametric modelling of 20th-century works, specific to the second section. These contents could be made available online for professional or academic use, as well as to create interactive forms of enhancement typical of the third section.

The DIMHENSION Library, which aims to achieve these goals, could be appropriately integrated into the MiC Digital Library, as it shares its values, objectives, and opportunities; in this context, it could be extended to cover the international architectural heritage to keep track of all technological solutions adopted in the 20th-century (Cernaro et al., 2025).

3. Materials and Methods: the DIMHENSION Library

The development of the web platform has adopted a methodological approach that can be traced back to the LOIN – Level of Information Need (as defined in the context of the UNI EN ISO 19650 standard) and described as the structured set of information necessary to meet specific information requirements in relation to stage of the process, purpose and actors involved. It has been only partially reworked to comply with the specificities of the research project (Figure 3).

The needed level of information meets the requirements of a development phase, in line with the LOIN/ISO approach, which provides for the definition of contents commensurate with the purpose and level of maturity of the product, avoiding unnecessary over-specifications in the initial phases.

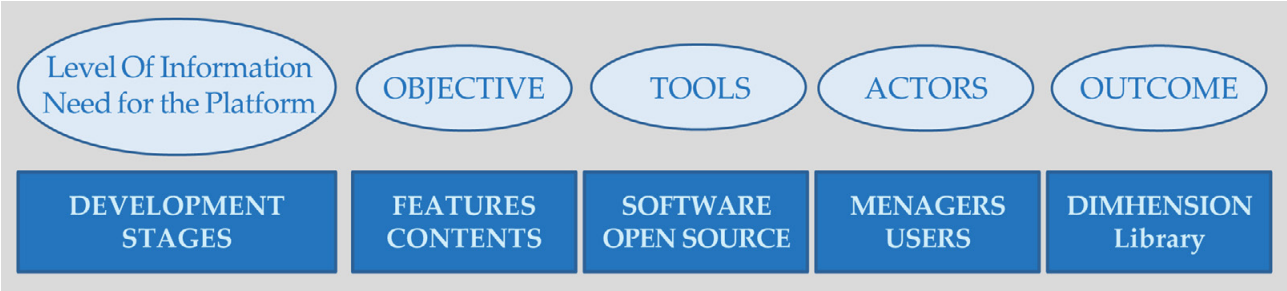


Figure 3 | Schematisation of the LOIN, structured for the DIMHENSION Library platform.

This approach is suitable for the validation of the conceptual and operational structure of the prototype application conceived, fully functional in its systemic, information and interaction logics, although intended to be inevitably enhanced through further developments in terms of information, performance and technical aspects, in line with the insights required by an ongoing digital transition.

The DIMHENSION Library has been implemented with the "AIM" of constituting a structured and dynamic bridge between a "Real Twin" and its "Digital Twin", as explained in the conceptual scheme developed starting from the philosophy expressed in the PRIN 2022 DIMHENSION (Figure 4).

To perform this function, the system must be able to receive, manage and correlate a heterogeneous and stratified set of information that defines the cultural asset far beyond its mere physical component, considering historical documents, materials and construction techniques, diagnostic data, point clouds and sensors, all elements that contribute to create a complete informative identity of the asset in its real dimension.

For this information to flow correctly within the digital twin and its BIM representations, it has been necessary to devise and structure the theoretical concepts in a concrete way on three cardinal sections (TOOLS):

- Asset Data Sheet;
- H-BIR;
- H-BIM.

These three components form the framework of the system and work together to ensure full adherence between real data and the digital counterpart.

The Asset Data Sheet has been conceived to become an element that allows you to organise and categorise the documentary and material information acquired in a systematic way during the operative research of different sources and to view the data both in a summary way and in detail through textual insights.

The H-BIR represents the semantic core of the platform, an intuitive and queryable interface that normalizes and connects all the tangible and intangible information processed, dividing it by period of belonging. Three sections have been designed to accommodate the synopsis of the sources; the operative investigations and the digital materials (including the previous ones) found for the work.

Finally, the H-BIM represents the container in which the digital products made through a parametric modelling process converge; they can be complete or partial models, depending on the level of development achieved; however, above all the section includes the BIM objects of the façade systems that can be downloaded and used as templates for a library for 20th-century architecture.

The elaboration of these sections required not only a careful definition of the informative contents, but also the design of two user-oriented, complementary, and interdependent systems (TOOLS):

- a graphic interface, the web frontend, intended for the end user, clear and functional for consultation;
- a back office frontend system for the operator (based on the logic set up in the backend), structured to allow the insertion, modification, and management of content in a controlled and coherent manner.

A crucial aspect of the project has been the need to allow the constant connection between the backoffice and the web platform, so that the populating of the

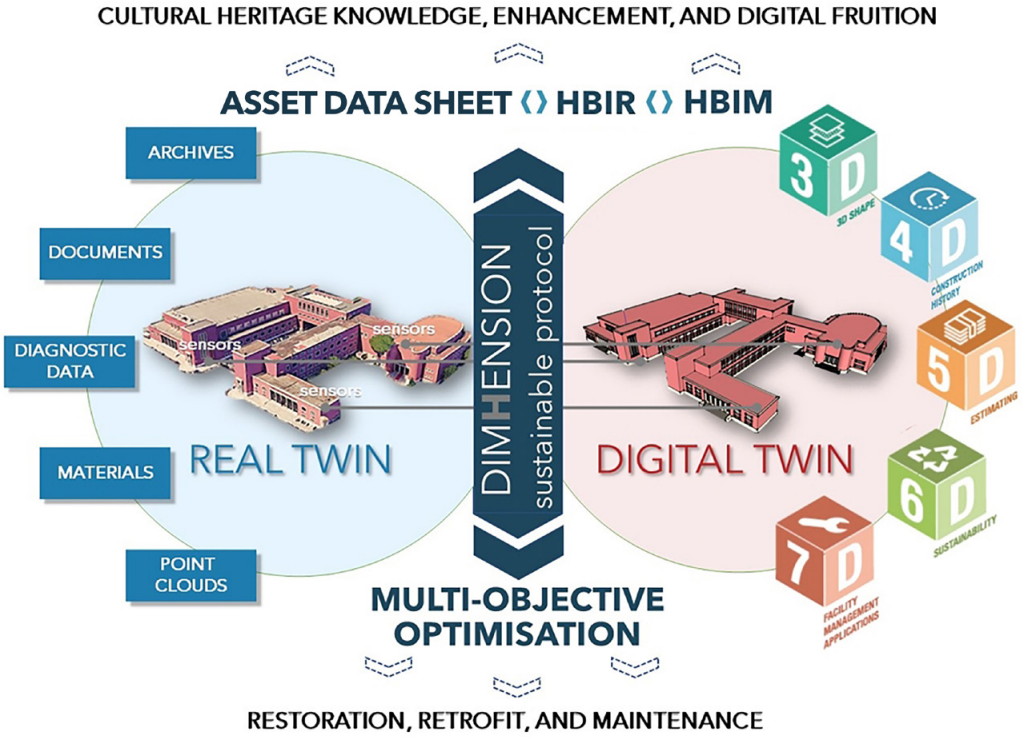


Figure 4 | Conceptual scheme of the DIMHENSION protocol for the integration between Real Twin and Digital Twin, aimed at the enhancement and digital use of cultural heritage.

information in the management system by administrators would automatically translate into the information that can be consulted by the end user (ACTORS). This is an essential prerequisite for multi-objective optimisation, which is put into practice through the development of the DIMHENSION Protocol that outlines the key steps of the process introduced.

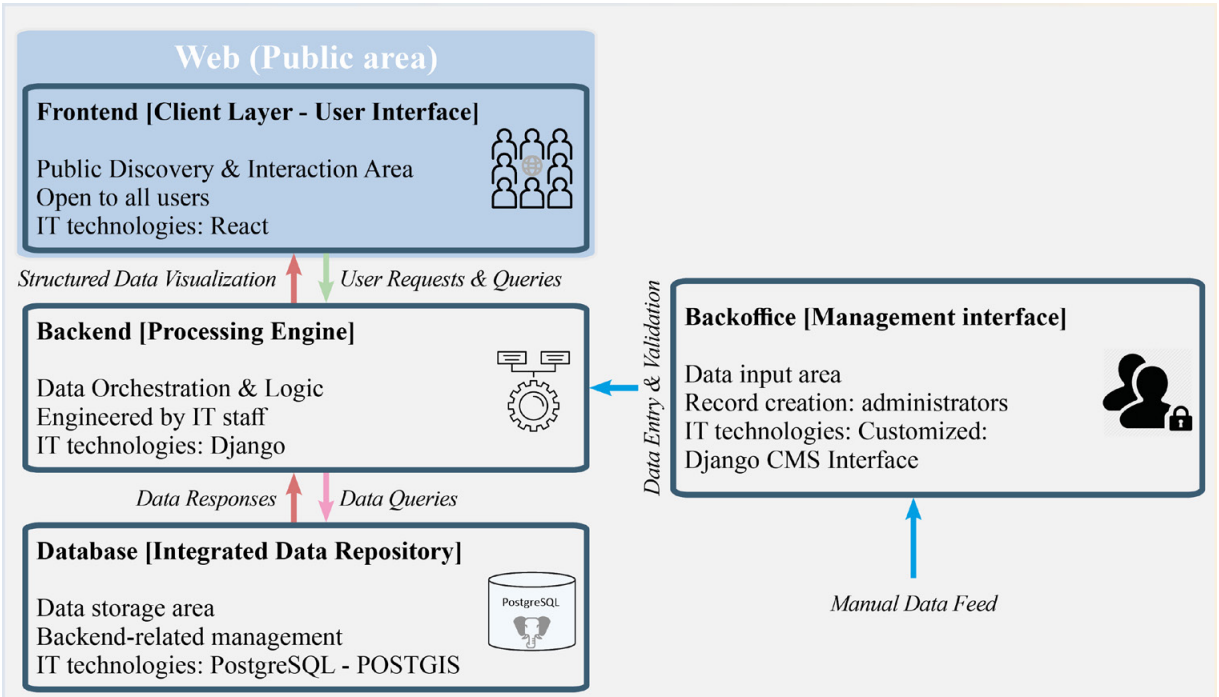
The will to create this technological apparatus required subjects with the IT skill within the research group, to be able to design and implement a structured database and the components necessary for the development of the web application.

These professionals have been supported by figures with skills in both IT and technical-construction and documentation of the built environment fields, to establish an effective dialogue to simplify and adapt the information logics of the sector – often complex, stratified and characterised by multiple levels of meaning – in the Cultural Heritage scenario.

Through this synergistic collaboration, it has been possible to translate the disciplinary needs of the world of architecture and built heritage into coherent application functionalities, making the platform adherent to the flows of thought and data organisation systems typical of 20th-century architecture.

Based on the identified needs and the criteria of scalability, interoperability and sustainability in the long term, an optimal set of open-source technological tools has been defined for the implementation of the platform (Figure 5). The choice of open source responds to the needs of flexibility, customization possibilities and lock-in reduction required by the project (understood as dependence on a single supplier or on proprietary technologies, which makes any migration or replacement over time difficult and expensive).

It also aims to promote the diffusion and ease of management of the platform in the long term. Indeed, the adoption of open technologies makes it possible to reach a wider pool of IT technicians already operating within administrations and institutions, facilitating the installation, maintenance and evolution of the platform even in contexts with limited resources or with policies oriented towards non-proprietary tools.



For the database, PostgreSQL has been chosen. It is a reliable and open-source solution, particularly suitable for the management of complex and relational data. The adoption of the PostGIS extension has also made it possible to natively support geospatial operations, enabling advanced queries on geometries (points, lines, polygons) and ensuring high performance in territorial processing. These characteristics are fundamental for a platform that must integrate surveys, documents, metadata and semantic structures with georeferenced components.
For the implementation of the backend, Django has been adopted. It is a Python framework that provides a complete ecosystem for managing the application logic on the server. Django offers a mature ORM for data access, a configurable routing system, an integrated authentication module, and an architecture based on the MTV (Model–Template–View) pattern, which clearly separates layers of presentation, logic, and persistence.
These features make it particularly suitable for the backoffice development, as the framework includes a highly extensible and editable admin panel, automatically generated from data models. This allows you to quickly and structurally build internal interfaces for content management and insertion, while concurrently ensuring security, reliability and coherence with the entire application stack.

As regards the implementation of the web platform, dedicated to the display of content by the end user, React has been used. It has been chosen for its high flexibility, highly modular structure based on reusable components and the ability to efficiently manage dynamic and responsive interfaces thanks to the Virtual DOM. For the definition of the style and to ensure modern, consistent and easily maintainable interfaces, Tailwind CSS has been adopted. It is a utility-first framework that allows you to develop responsive and customizable layouts directly within React components, reducing custom CSS code and improving productivity.
Furthermore, given the importance of territorial and cartographic components in the description and con-textualization of architectural and urban heritage, it has become necessary to integrate tools dedicated to spatial representation. To this end, the open-source JavaScript library Leaflet has been used, which is particularly suitable for the creation of interactive and mobile-optimised maps. This software allows you to efficiently manage layers, markers and georeferenced geometries, significantly improving the user experien-ce by facilitating the consultation of content located on the territory. Each of these tools performs specific functions and contributes, in a complementary way, to the construction of a coherent and stable informative environment.

Figure 5 | Logical diagram of the system and applications used.

The database architecture is not only a structured set of tables but represents the relational engine that governs the connections between all the points of interest in the project.

The insertion model activated to relate the backoffice and the web revolves around the architectural work, a central node to which heterogeneous information is connected: history, references, entities and connected

profiles, construction elements, building materials and BIM models. This organisation ensures a clear and coherent structure, in which each content acquires value through connections with the other parameters and its relationship with the architectural asset (Figure 6).

The use of keys and connections ensures the integrity and consistency of the informative system, avoiding redundancies and allowing transversal queries. This structure finds operational applications in the backoffice, an environment intended for administrators in charge of content management, where the fields that can be filled in are defined and the first checks are carried out on the data entered. This keeps the entire informative model aligned right from the input stage. The adoption of standardized procedures and guided wizards makes the back office data population process intuitive, simplifying data entry through clear interfaces that are customized according to the type of information to be managed.

An example of this approach is shown in (Figure 7) and (Figure 8). The first illustrates the workflow implemented for defining a constructions element and their characteristics. To do so, from the back office environment, it is possible to launch a personalized wizard to define each layer composing the element, together with its function and constituent materials. All constructions element present in the project can then be added and distinguished according to their position.

The second figure illustrates the selection of ownership regime. The first interface is used to select the type of owner—first owner, intermediate owner, or current owner—followed by a second interface for specifying the corresponding ownership period. For both procedures, the results are immediately visible in the backoffice and are also displayed in the public web interface, ensuring continuity between data entry, management, and consultation.

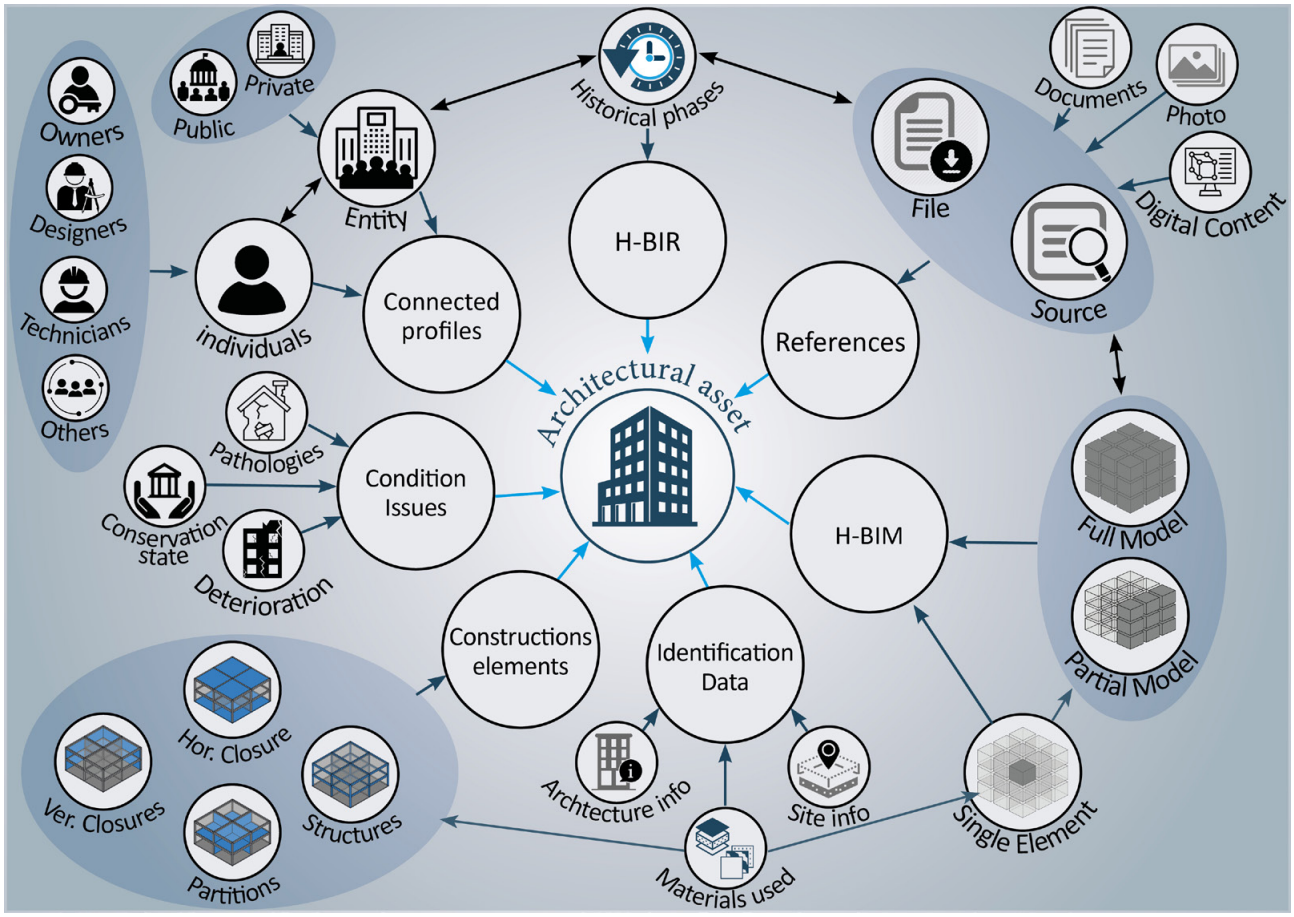


Figure 6 | Conceptual scheme of informative connections for the management of an architectural asset.

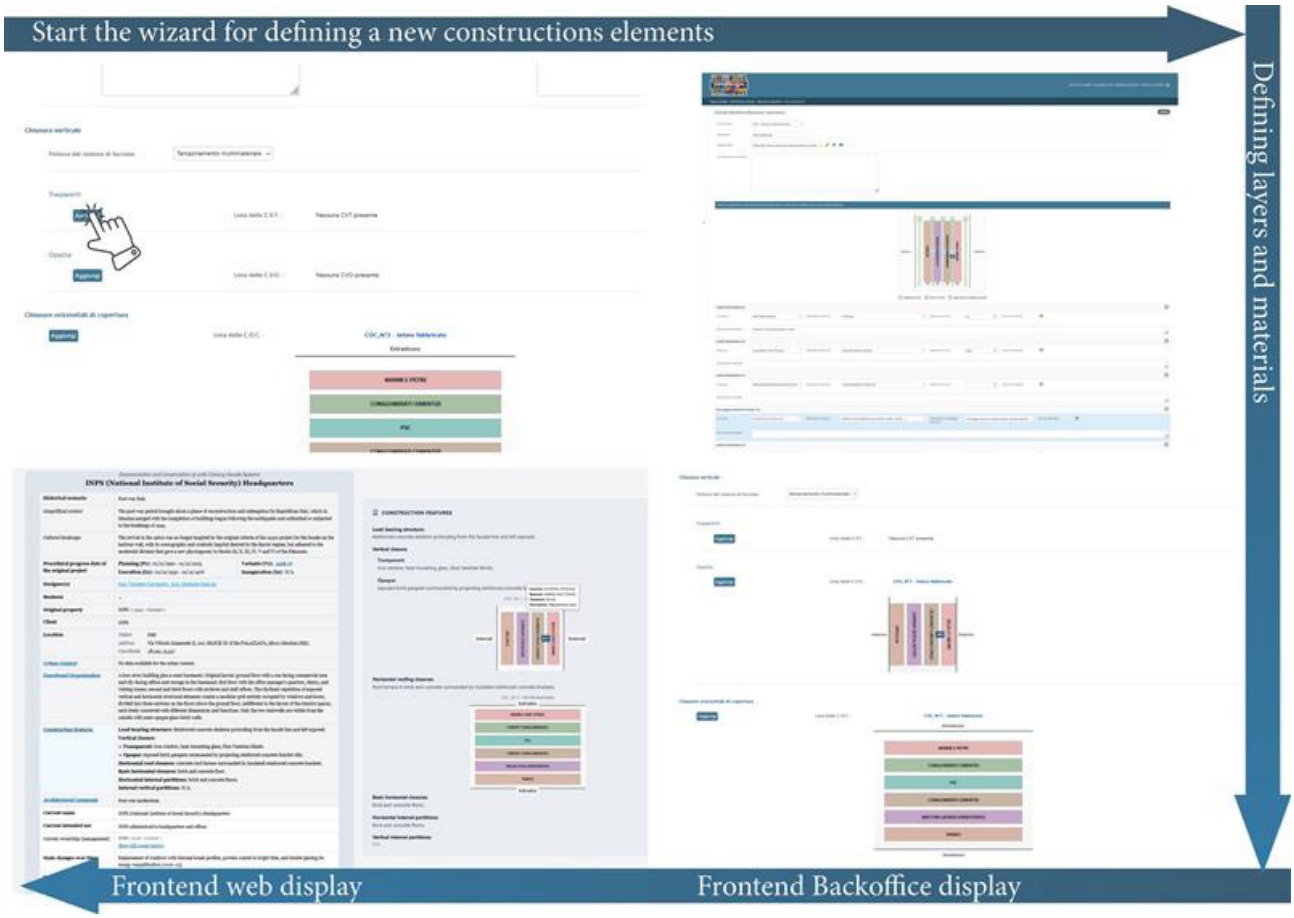


Figure 7 | Use of the Wizard for defining the constructions elements and the associated materials.

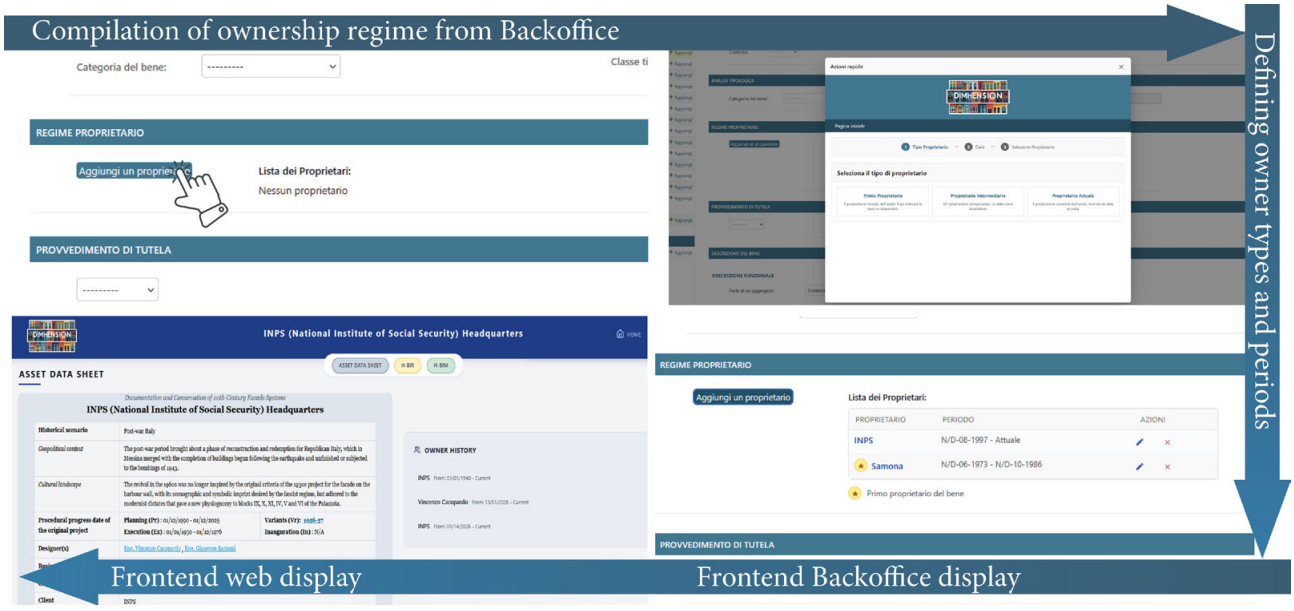


Figure 8 | Use of the Wizard for defining the ownership regime.

4. Results: the digital gateway to the 20th-century architectural heritage

The conceptual framework produced (OUTCOME) has been declined to host information and digital content related to the Italian architectural heritage of the 20th-century and to its characteristic façade systems (Figure 9). The resulting web application provides an inclusive digital environment accessible to a wide range of users, including non-specialist ones, acting as a gateway to exemplary works selected for their historical-cultural value and technical-constructive features, whose knowledge should be disseminated for conservation and protection purposes.

The interface for online fruition has been designed to ensure a clear and accessible consultation experience, supporting multiple approaches to explore the architectural heritage.

The website has been described below by simulating the search for a specific building. It opens with a home page that plays the role of landing page and represents the first point of contact between the user and the platform. This section concisely presents the project objectives, the reference context and the main research topics addressed. The home page also has the function of orienting the user, offering direct and intuitive access to the main website sections, both through dedicated graphic and textual elements and the navigation bar (navbar). From here, the user can easily reach the search area, which is the hub of browsing experience.

The search can be carried out in two alternative but equivalent ways in terms of results. The first one is mainly data-based, can be accessed from the "Search by Data" section (Figure 10) and allows you to query the database via structured fields and specific filters. The second one is based on geographical exploration and is available on the "Search by map" section (Figure 11), designed for a more visual and spatial consultation.

The choice depends on the user's preferences in terms of consulting similar web tools or on search objectives that can make it easier to adopt one or the other.

For instance, if precise information is available, one could opt directly for the first one which, following the application of filters, produces as result the work or a list of works with similar characteristics.

On the other hand, if the aim is to first explore the geographical distribution and then make the selection, there is a second option, based on an interactive map, through which to geolocate the assets and apply other types of filters. Here, the map assumes a leading role in the search experience and, thanks to the use of a personalised graphic pin, designed to visually convey some fundamental information about the asset, allows the user to quickly orient himself already in the exploration phase, immediately distinguishing "Construction period" and "Finish of the façade system" as well as to know if complete or partial H-BIM models are present for the work on the platform.

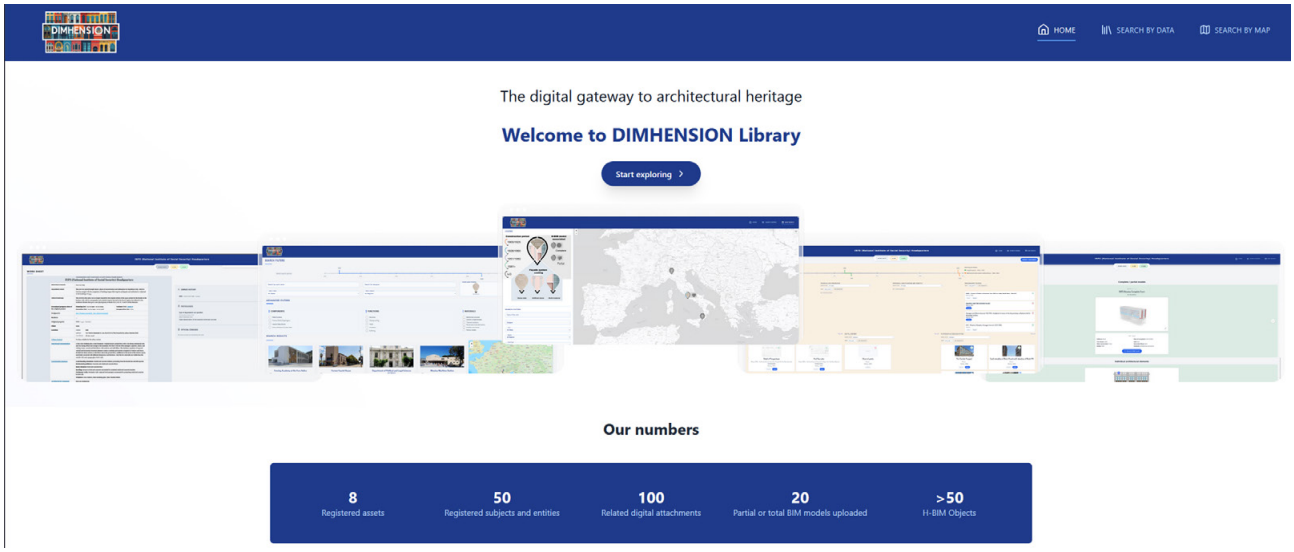


Figure 9 | The home page of the "DIMHENSION Library" web platform.

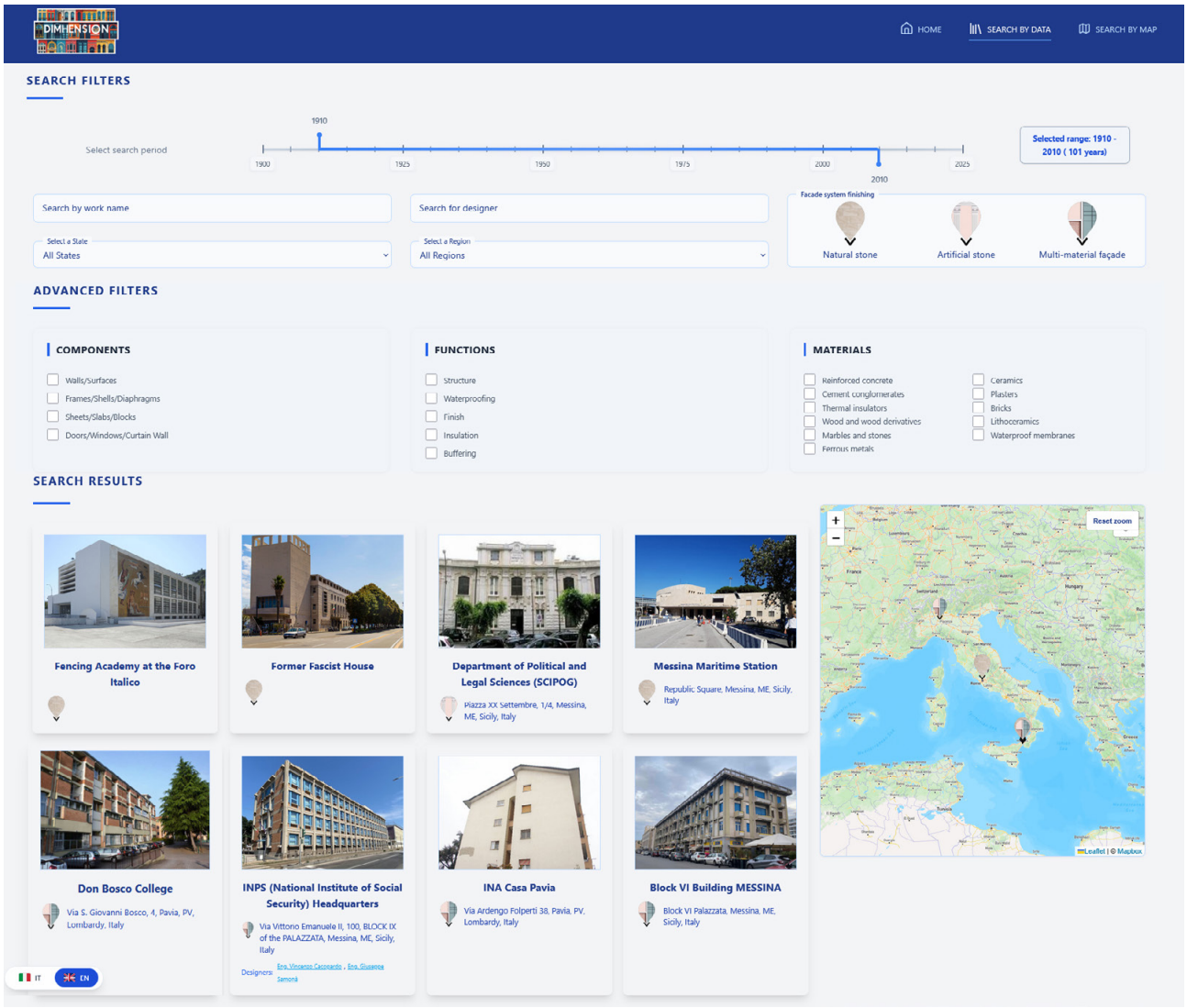


Figure 10 | First way of search in the DIMHENSION Library: mainly based on data.

Apart from the interface, the two procedures are largely identical, sharing filter parameters and graphical elements, and ensure consistent results.

On both search pages, the filter criteria are organised into two main sections.

In the first section, named “Search filters”, it is first possible to identify the construction period by defining a time range from the beginning of the 20th-century to date. In the “Search by data” page it is provided as a timeline to be managed by setting the starting and ending extremity of the interval of interest with the cursor. Instead, in the “Map Search” page it is organised according to predefined time intervals (1900/1925; 1926/1950; 1951/1980; >1981; ND – Not Definable). Subsequently, the database is queryable by means of entries through which to identify and locate the asset:

- Work name;
- Designer;
- State;
- Region;
- Façade system finishing (Artificial stone; Natural stone; Multi-material).

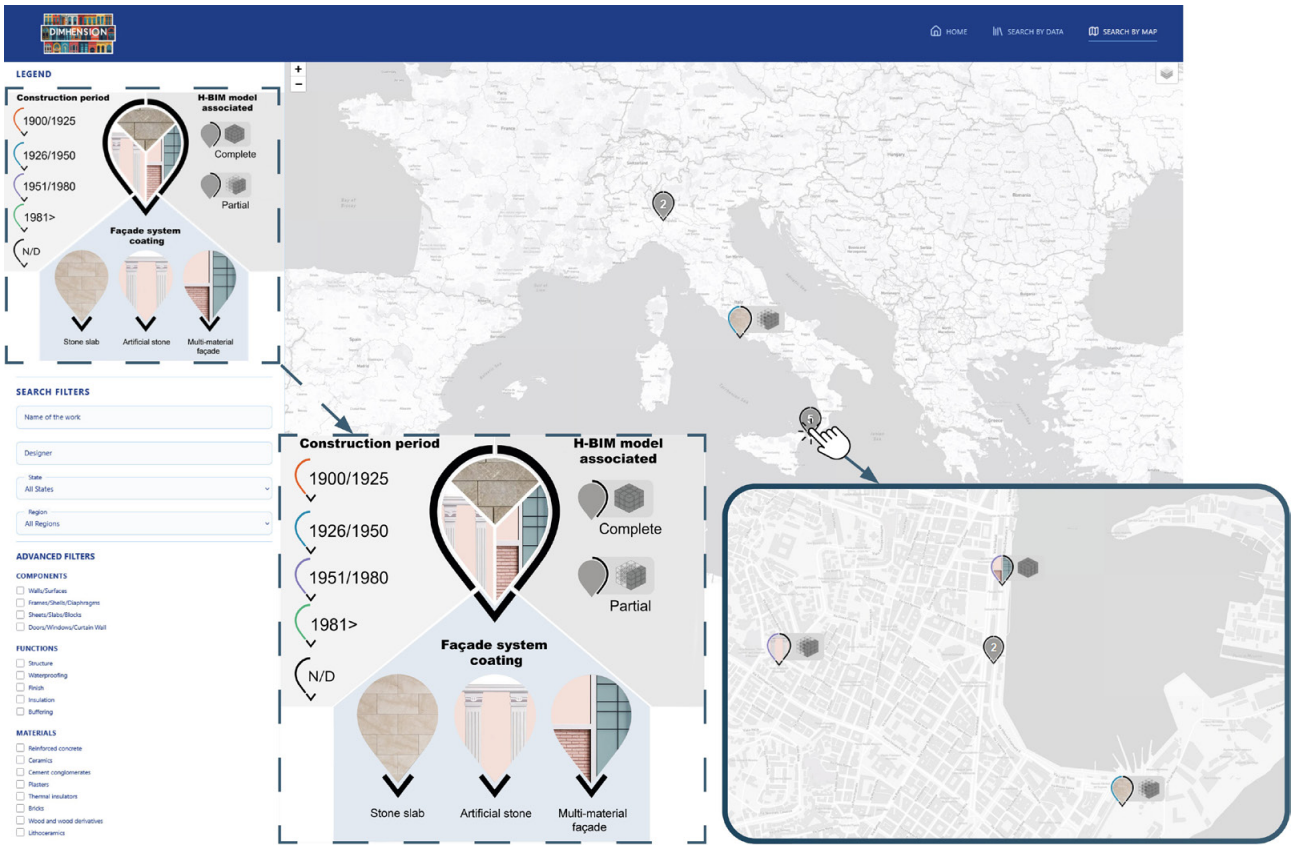


Figure 11 | Second way of search in the DIMHENSION Library: mainly based on map.

The second section, named "Advanced Filters", provides keywords to make a selection based on the technical-constructive characteristics found in works of the 20th-century, in accordance with:

- Components (Walls/Surfaces; Frames/ Shells/ Diaphragms; Sheets/Slabs/Blocks; Doors/Windows/ Curtain Wall);
- Functions (Structure; Waterproofing; Finish; Insulation; Infill);
- Materials (Reinforced concrete; Cement conglomerates; Thermal insulators; Wood and wooden products; Marbles and stones; Ferrous metals; Ceramics; Plasters; Bricks; Lithoceramics; Waterproof membranes).

In summary, through these criteria the user queries the database for two purposes:

- finding a specific work, indicating its name in the appropriate field, Work name, in the Search filters section;
- identifying a set of works having as common characteristics those chosen during the application of filters.

The search results are displayed differently depending on the selected mode. In "Search by data" the presentation cards of the assets, located in a small cartographic representation, will prevail. In "Map Search" the outcomes will be presented on an extensive georeferenced basis and the cards will be displayed after selection using the graphic pin described above (Figure 12).

Currently, the platform includes eight works. Thanks to their filing it have been derived censuses of over fifty subjects/entities (owners, clients, designers, companies, suppliers, etc.), insertions of over one hundred attachments (highlighting any correlations), uploads of H-BIM models (partial and total, even more than one for each work if necessary) and a wide range of H-BIM objects for a total of fifty entities (Figure 9).

The quantitative datum, in addition to describing the progress of the platform population, also reveals its relational nature: in fact, the work is not intended as an

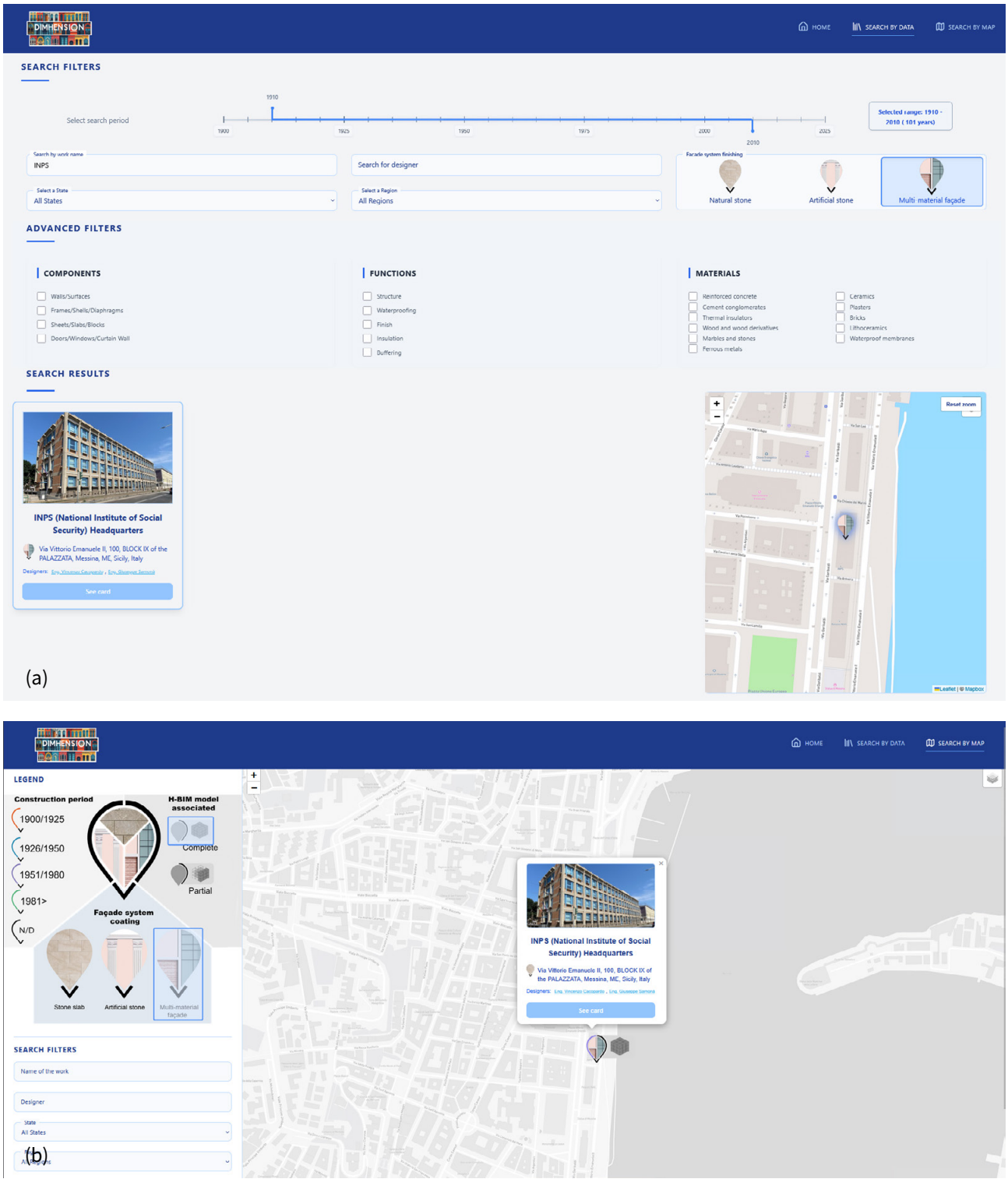


Figure 12 | Search a specific work: (a) using "Search by data" page; (b) using "Search by map" page.

isolated element but as a node of a network in which documents, stakeholders and technical information contribute to building an integrated knowledge. In this perspective, attachments and participants in the process do not play a merely "accessory" role, but become structural components of the information assets, useful for

tracing sources, motivating choices, following changes, reconstructing responsibilities and phases of design and management.

Unlike other repositories, the library does not primarily focus on geometric objects, but on a structured data system for describing architectural heritage assets.

In addition, a template version has been shared for each one that the user can download and reuse for modelling works with similar characteristics.

Once the search has been carried out and the asset has been identified, clicking on the card will take you to the platform page where it will be possible to consult for each building: Asset Data Sheet, H-BIR repository and H-BIM model with the related parametric-informative objects (Figure 13). In this way, a key transition takes place from the "panoramic level" (search) to the "level of detail" (consultation), allowing to proceed immediately from the identification of the work to its structured reading. In this environment, navigation is designed to facilitate both the user who is looking for accurate information (e.g. location data, a subject involved, a technical specification) and those who need to reconstruct an overview, following the links between sections and contents.

To illustrate and describe the web interface of the DIMHENSION Library, one of the eight works surveyed, the INPS headquarters in Messina, was chosen as an example of the results that can be obtained with such a digitisation project.

When the page opens, the presentation of the asset appears through a gallery of images, a brief description accompanied by essential information for location and dating, the identification of the original designer and the current owner (Figure 14).

The access to the Asset Data Sheet, H-BIR and H-BIM sections can be done either by clicking on the related button located in the central bar at the top of the page, or by manually scrolling down through the cursor.

In this way, the user can choose a "jumping" navigation between the main contents or, alternatively, a continuous and progressive reading of the information set. Each section, graphically distinguished by a different background colour, shows the results of the population of the backoffice fields (Figure 14), making the separation between thematic areas immediately perceptible and facilitating orientation even in the presence of tables or numerous fields.

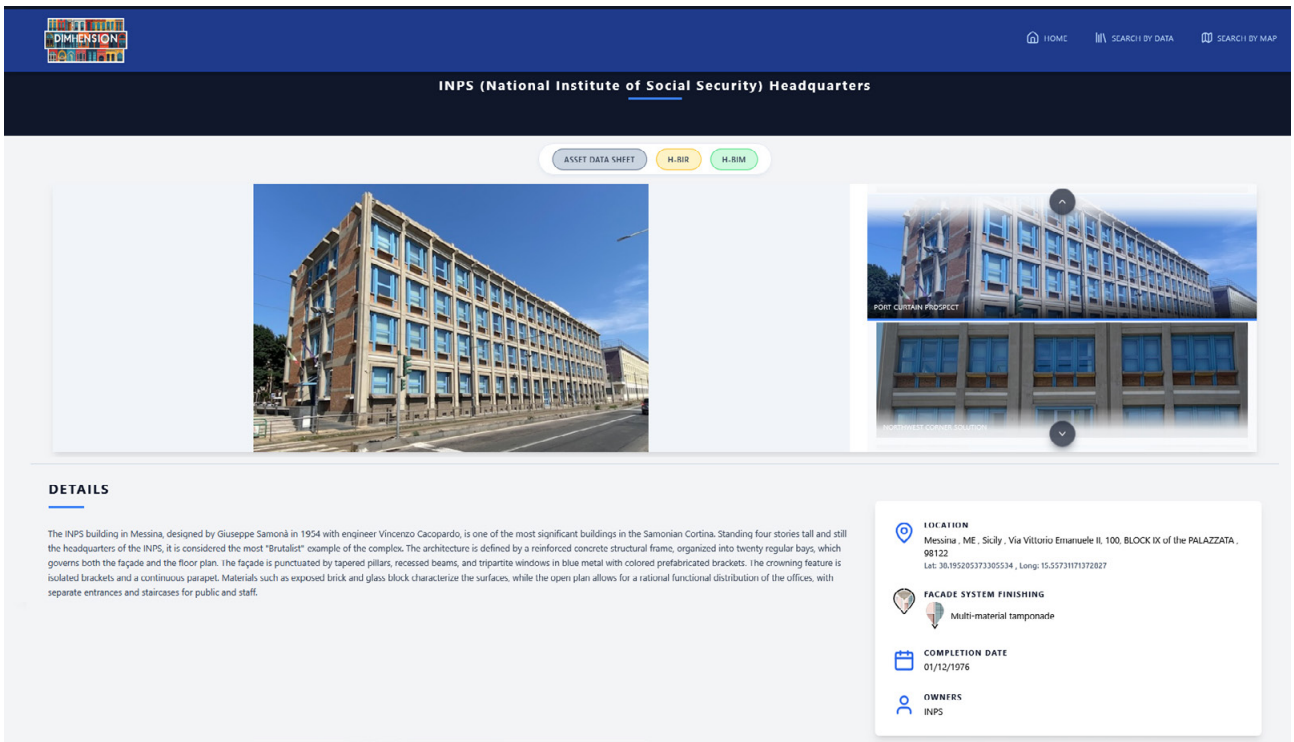


Figure 13 | Opening of the web page dedicated to the work: a brief presentation by means of images, short descriptions and essential information. Illustrative path through the INPS headquarters in Messina.

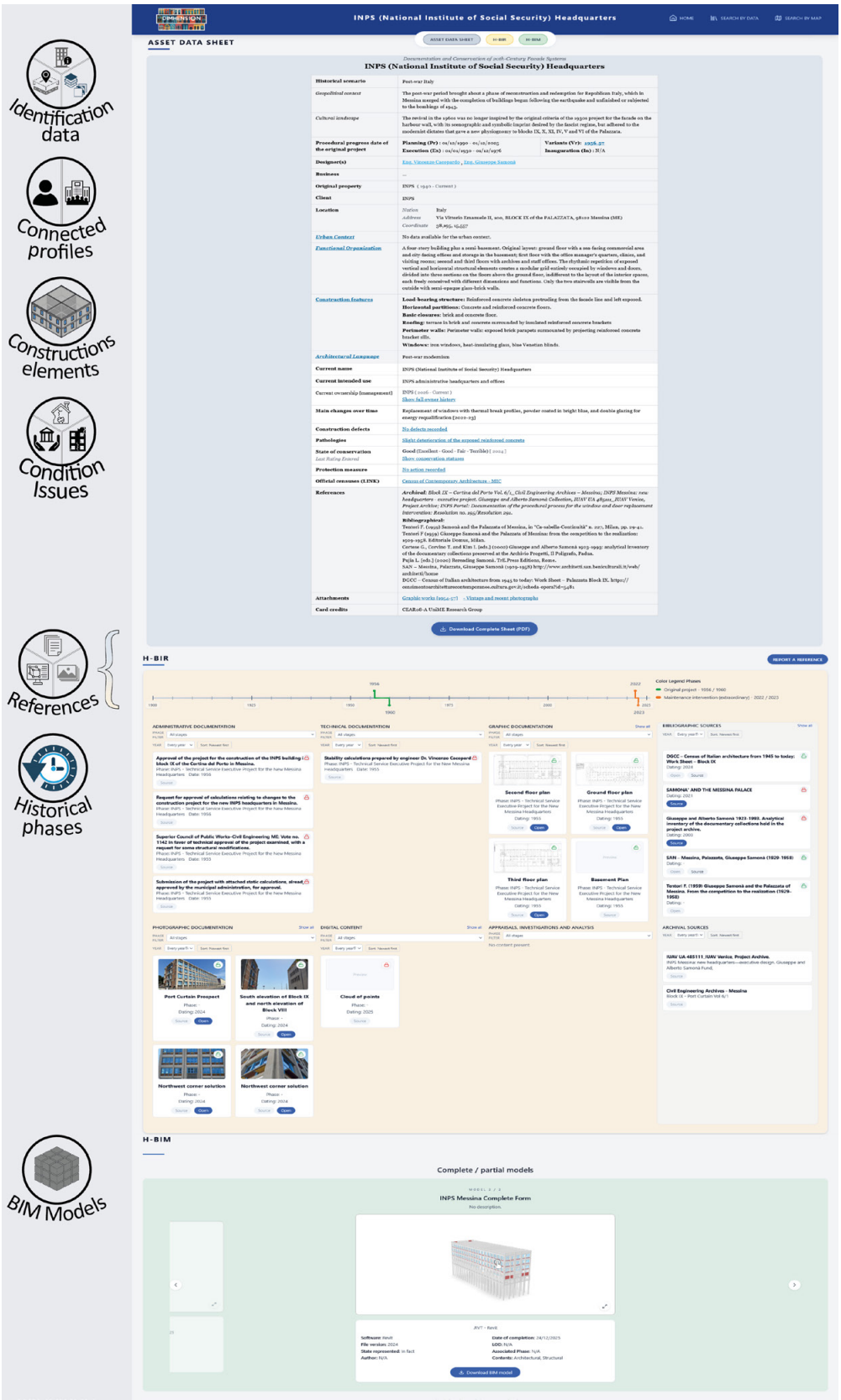


Figure 14 | The organisation of the asset page into sections and the distribution of the contents between the Asset Data Sheet / H-BIR / H-BIM. Illustrative path through the INPS headquarters in Messina.

The intent pursued has been to guide the user in a gradual knowledge of the asset, starting from synthetic descriptions to reach others of detail, sometimes activated by means of pop-ups.

Although each section is assigned to different functions, the three thematic areas are strongly related.

The Asset Data Sheet is organised in such a way as to structure the descriptive and identifying information in a clear and delineated way, including personal and contextual data, as well as related profiles (e.g. owners/clients, designers, company). It also reports aspects on the technical-construction characteristics and composition of the elements (systems, materials and components), together with fields dedicated to pathologies, defects and state of conservation. Some items, highlighted in blue and underlined as links, open an extended consultation in the side panel with details and additional content (history of the ownership regime, functional description, architectural language, etc.), improving the knowledge of detailed information without weighing down the main table. The command to download the entire PDF sheet is also available, including the supplementary contents and any in-depth sections consulted.

The H-BIR section represents an environment for consultation and organisation of historical and technical-documentary knowledge of the asset (Figure 15).

At the top, a timeline summarises the evolution of the work and structures its reading in phases, which can also be distinguished by a chromatic legend: each temporal segment corresponds to a significant period (e.g. original project, subsequent interventions) and quickly orients the search.

Below the timeline, the content is organised into seven sections, designed to contain all types of digital or digitised data available. These are: “administrative documentation”, “technical documentation”, “appraisals, investigations and analyses”, “bibliographic sources”, “graphic documentation”, “digital content” and “photographic documentation”.

The individual sections allow to filter the contents by phase and, where applicable, by year of implementation. It is also possible to download the contents when free of copyright constraints (green padlock) or to consult the source associated with the data in any case.

Finally, the subsection highlighted with a softer coloring works as a “phase view”: it filters and collects only the contents referred to a selected phase, starting from the first known configuration to all subsequent phases found. In the latter, the most significant interventions are highlighted, indicating whether there are changes to the façade, structural changes or variations in the functional structure, so as to make the type of transformations carried out on the asset over time immediately legible.

The H-BIM section represents the area of the platform dedicated to the consultation and use of digital information models associated with a specific work (Figure 16). In this space, the model is not intended as a simple 3D representation, but as a container of information that can be queried and compared, in continuity with the historical-documentary and descriptive data present in the other sections.

The first part shows the catalog of complete and/or partial BIM models: each model is related to the asset and accompanied by metadata that clarifies the date of construction and above all the historical phase to which it refers (i.e., the evolution of the building that the model “photographs”). This makes it possible to explicitly link the model to the history of the construction and to compare, when present, versions produced at different times or in relation to specific interventions, transforming the catalogue into a diachronic reading tool. In practice, the user can combine models referring to different phases to verify dimensional variations, replacements of component elements, changes of intended use or redefinition of spaces, integrating visual analysis with the consultation of information parameters.

For each model, the section contains information useful for reuse and correct interpretation, including the authoring software used and version (essential elements for compatibility and workflow), level of development (LOD), author and content included. The command to download the BIM model is also available, making the transition from consultation to operational reusability immediate.

The second subsection, dedicated to the individual technical-construction elements, collects the H-BIM objects/components extracted and made available as a library: these are objects that can be downloaded and ready to be reused in other projects, maintaining information coherence and document quality. This approach enhances the digital heritage produced, as it allows the reuse not only of the whole model, but also of selected parts (e.g. windows and doors, façade systems, recurring structural components, finishing elements), with obvious advantages in terms of time and data uniformity. The main metadata (software and versions, associated historical phase, date of modelling, LOD) also appear in these sections, so as to ensure traceability and interoperability in reuse, as well as making transparent the origin of the object and the context from which it was extracted.

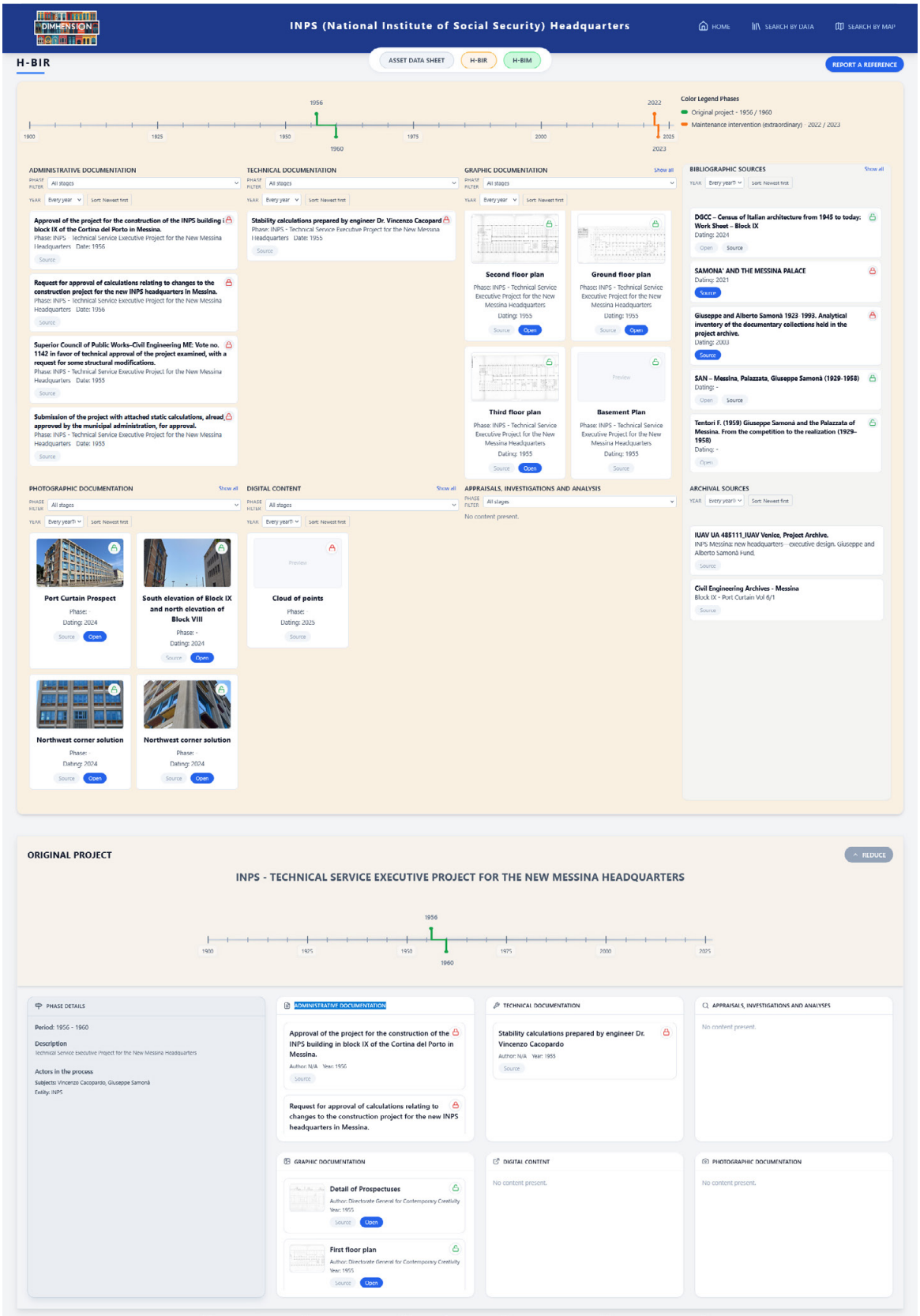


Figure 15 | The organisation of the H-BIR section. Illustrative path through the INPS headquarters: the main phases in its construction history and the sources that prove it.

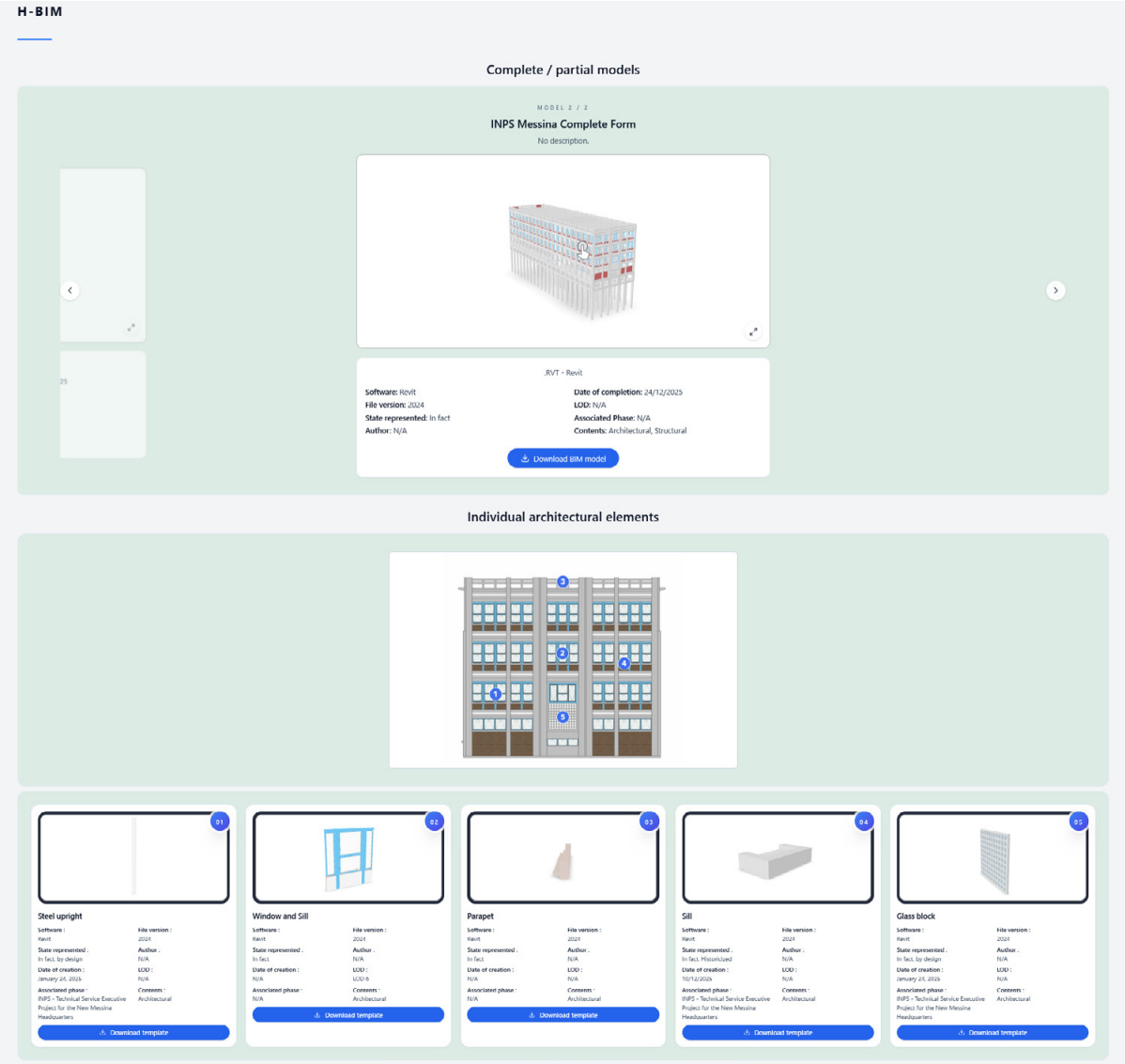


Figure 16 | The organisation of the H-BIM section. Illustrative path through the INPS headquarters: from the H-BIM Model to the H-BIM objects to be downloaded by users.

When available, the objects are also related to the materials that compose them, recalling the relative material sheets on the platform: in this way the user can connect components and stratigraphies/finishes to the technical information of the materials (characteristics, notes and references), obtaining a more complete and coherent reading of the construction element. This connection reinforces the information dimension of BIM, because it allows you to move from geometry to technical knowledge (performance, critical issues, installation or maintenance indications) and to keep objects and supporting information aligned. Overall, the H-BIM section is configured as an environment not only for consultation but also for controlled reuse and knowledge transfer, in which models and components become operative resources for analysis and design, as well as tools for documenting and understanding the evolution of the architectural heritage.

5. Discussions: the challenges of the DIMHENSION Library

Digital platforms developed for the knowledge, conservation, and enhancement of cultural heritage have highlighted several structural, epistemological and

operational challenges which have significantly informed the design of the DIMHENSION Library. From a structural perspective, key limitations include the inhomogeneity of cataloguing data and the prevalence of centralised management systems. In response, the research focused on 20th-century architecture, with the aim of providing an accessible archive—also for non-specialist users—capable of going beyond mere cataloguing to support interpretative research. In this context, the possibility of using the platform as a reusable H-BIM object library represents a significant innovation within the digital landscape of modern architectural heritage.

A partially unresolved issue concerns data input, which is currently restricted to platform administrators. At present, external contributors can submit data via email, with access granted only after validation. However, genuine cultural accessibility requires further simplification of these procedures, alongside the definition of shared IT standards at an international level (e.g., ontologies, codification systems, open H-BIM frameworks).

This limitation, of an epistemological nature, often leads to simplified or "interpreted" representations of cultural heritage within digital environments. The inclusion of the H-BIR section, in which all the sources used—bibliographic, archival, diagnostic, and digital—are declared, offers not only an account of the various stages in the history of the project's development but also an authentic insight into the scientific and operational support employed. This overcomes a stereotypical and static view of the data and ensures that users are kept informed of updates and the completeness of the data.

Operational challenges—related to technological obsolescence, data complexity, and the experimental nature of digitalisation processes—are inherent to the rapid evolution of the informational landscape and can only be resolved through a commitment to ensuring that any initiative aimed at understanding, preserving, accessing and promoting Digital Cultural Heritage is designed to stand the test of time. In this direction, it is intended to further develop the DIMHENSION Library by following the constant innovations that will arise in the near future, with the aim of obtaining a cultural device that is easily accessible and widely shared.

6. Conclusions

The DIMHENSION Library, developed within the framework of the PRIN 2022 Research Project, is conceived as a modular, open, and expandable system, capable of dynamically linking the cataloging of 20th-century works with a digital repository, the H-BIR, thus allowing scholars, researchers, technicians, or simply curious individuals, a historical, constructive, and interactive knowledge of the cataloged works; this platform is designed to be updated over time and replicated for other historical periods as well, without the need for code refactoring interventions.

Among the main directions for future development there are the automation of information flows between databases and BIM models, the integration of IoT sensors for monitoring and predictive maintenance, the use of artificial intelligence techniques for data processing, and the collaborative expansion of the database through the contribution of accredited users. Recently, the university computing center in Messina, CIAM, granted a dedicated domain, which will allow wider dissemination and sharing of the platform, enhancing its accessibility and potential development on a larger scale.

Despite these prospects, several critical issues remain, many of which are common to digital platforms. These include limited financial resources for long-term maintenance, as well as challenges related to implementation and effective deployment. As a result, many initiatives risk being abandoned once initial funding ends, particularly when the database is not yet sufficiently extensive to ensure user engagement.

To address these issues, it is essential to foster continuous collaboration with archives, restoration institutes, and heritage authorities. Such partnerships could contribute to the enrichment of the H-BIR repository through the integration of digitised documentation. At the same time, participation in national funding programmes—such as those promoted by the Ministry of Culture (MiC) for inclusion in the Cultural Heritage Library—represents a strategic opportunity to consolidate the DIMHENSION Library as a reference resource for 20th-century architectural heritage within ongoing digital transition processes.

7. Video data

The idea of attaching an explanatory video to the paper about the use of the DIMHENSION platform arose from its current prototype status. It will be available online from early September at the link www.dimhension.unime.it.

The video can also be downloaded from:
https://polipapers.upv.es/index.php/vitruvio/article/view/25605/18500

Notes

[1] PND_National Plan for the Digitisation of Cultural Heritage / Digital Library (MiC, 2023); DATI.BENICULTURALI.IT, an experimental platform for the publication of linked open data (MiC, dati.cultura.gov.it); DGCC_Atlas of Contemporary Architecture (MiC-DGCC, atlantearchitetturacontemporanea.cultura.gov.it).

[2] DoCoMoMo_International and Italy – Minimum Documentation Fiche (DOCOMOMO Italia, docomomoitalia.it/catalogo/ and docomomoitalia.it/fiche/); MAXXI Architecture_Architecture Archives Centre (MAXXI, collezionearchitettura.maxxi.art/patrimonio/); MART_20th-century Archive (MART, archive.org/details/mart-archivio-del-900); Europeana_European Digital Heritage Portal (Europeana Foundation, europeana.eu/; Europeana Strategy 2025).

[3] DCH Laboratory – Digital Cultural Heritage, UniPD (UniPd, beniculturali.unipd.it/www/servizi/laboratori/laboratorio-dch/); Digital Heritage – Digital tools for the study, enhancement and communication of cultural heritage, UniBO (UniSI, digitalheritage2025.unisi.it/; UniBO, beniculturali.unibo.it/it/ricerca/ambiti-di-ricerca/digital-heritage/); DHEKALOS - Digital Heritage and Landscape Ecosystem / DISTORI Heritage, UniPVM (UniVPM, dhekalos.it/; MiC, cultura.gov.it/virtualtour).

[4] (MIAH, cims-miah.com/#/home; 3D models Library for Heritage IT Jordan, hitj.centroictbc.unisa.it/).

[5] See Note no. 1.

[6] See Note no. 2.

[7] See Note no. 3.

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