

## C3 – International Student Workshop in Nicosia

# Enabling data-driven, multi-scale and multi-modal studies of historic urban environments

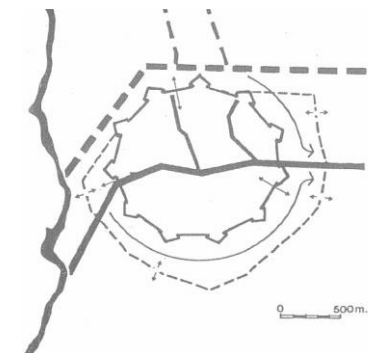
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GEORGIOS ARTOPOULOS

Assistant Professor, The Cyprus Institute

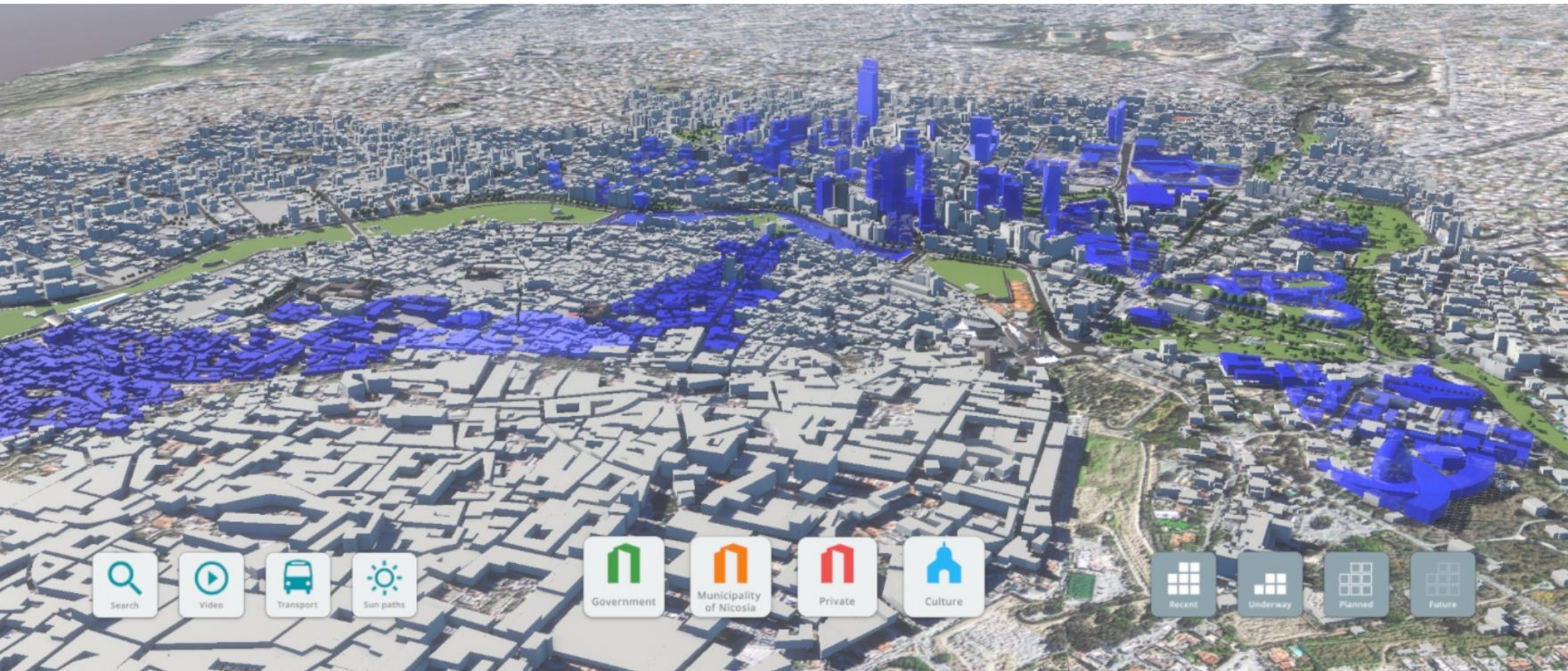
MARISSIA DELIGIORGI

Research Assistant, The Cyprus Institute



Cyprus Workshop, May 2022









Local heritage assets can play a critical role in successful urban regeneration projects

> socio-economic benefits from the construction and tourism sectors







**Urgency for safeguarding**

**Proven socio-economic benefits**

**Expected need for renovation**

## THE GAP, AND SUBSEQUENT CHALLENGES

Authorities lack of:

Data (knowledge of change, in time); and,  
Tools (monitoring, visualization > interpretation).

Professionals lack of:

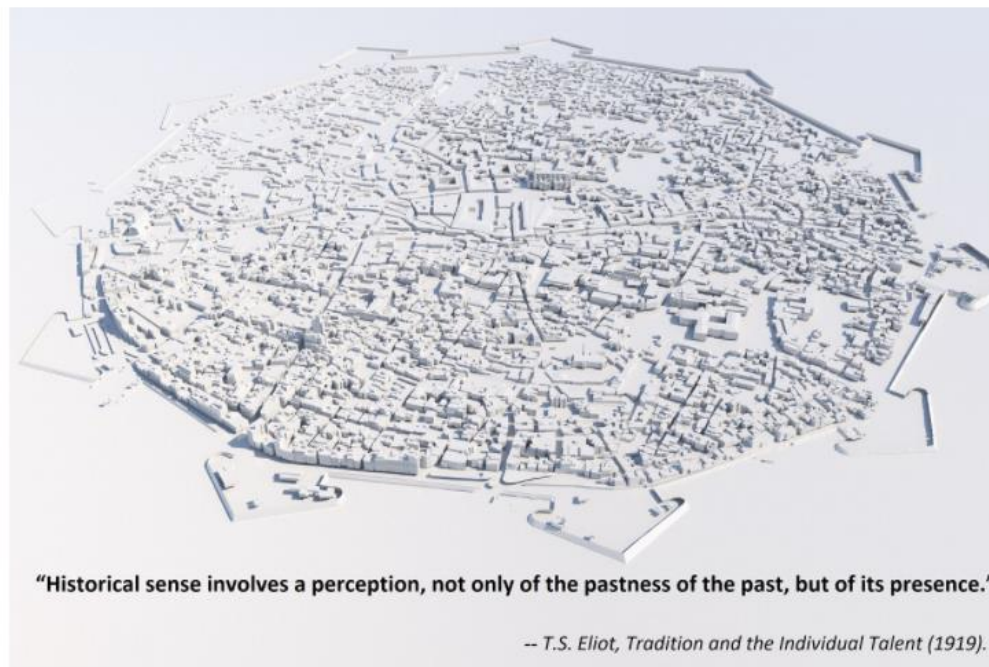
Data (interdisciplinary know how, cost, labour).

Owners lack of:

Incentives, guidance for renovation, cultural value of heritage.

#### KEY EXTERNAL LINKS

- > DARIAH ERIC WG Digital Practices for the Study of Urban Heritage
- > Digital Practices for the Study of Urban Heritage blog
- > ENI CBC MED BEEP
- > Department of Antiquities Cyprus
- > ICOMOS Cyprus
- > Royal Institution of Chartered Surveyors
- > JPI Urban Europe



EUROPEAN UNION

European Regional  
Development Fund

The project PERISCOPE INTEGRATED/0918/0034 is co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research Innovation Foundation.

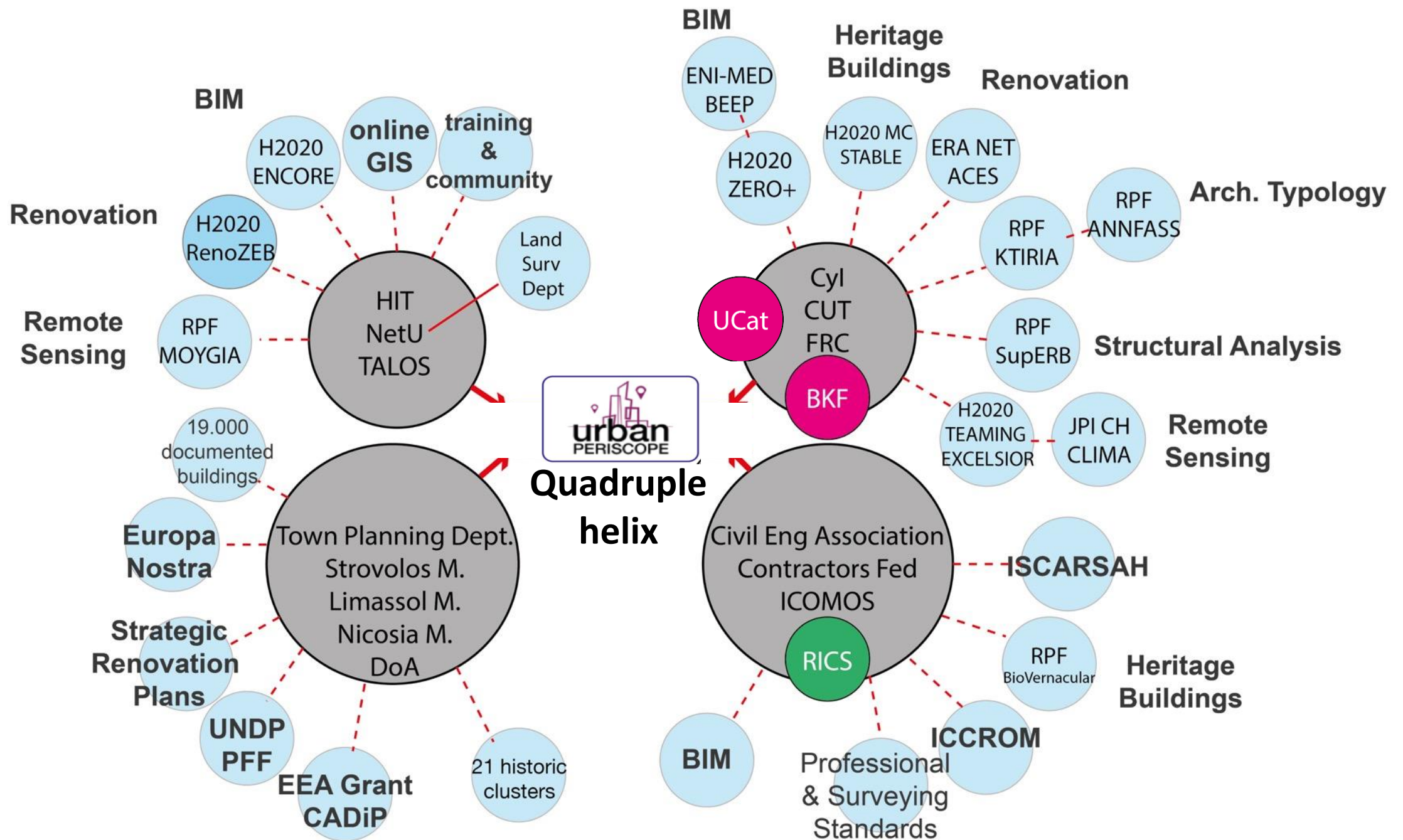


Κυπριακή Δημοκρατία



Διαρθρωτικά Ταμεία  
της Ευρωπαϊκής Ένωσης στην Κύπρο







# WHAT

This online BIM-enabled platform will allow holistic, integrated research inquiries that range in **scale** (from a macro scale environmental monitoring of clusters of historic buildings to the structural analysis of individual buildings), as well as in **time** (monitoring of the development of cities).



Cyl's Time Machine (4D): Nicosia (1951)



Cyl's Time Machine (4D): Nicosia (2016)

PERIsCOPE aims to produce an innovative online platform for the:  
identification,  
documentation  
classification, and  
renovation of heritage buildings,  
to be exploited by a variety of stakeholders related to the conservation and retrofit activities.



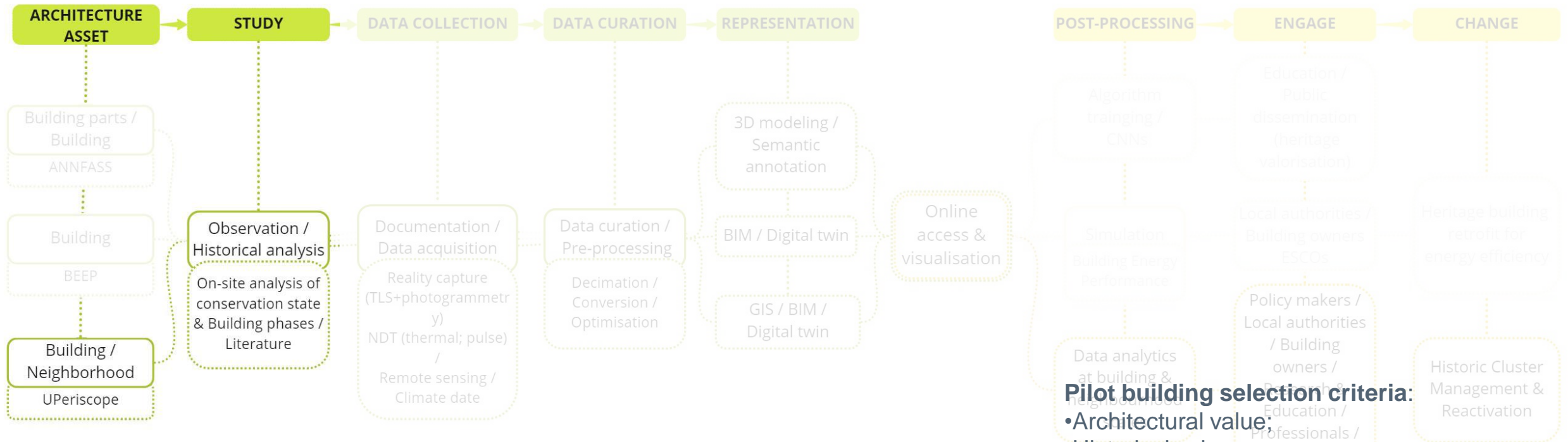
# HOW

## **PERIsCOPE's methodology:**

- (i) Mapping and parametric management of data of heritage buildings through BIM;
- (ii) Restoration and renovation requirements, policies, pool of examples & step-by-step guidelines;
- (iii) Structural condition and environmental impact data (LCA of heritage);
- (iv) Classification of architectural typology and architectonic features with a 3D precision documentation workflow (UAV, photogrammetry, TLS, etc.);
- (v) Monitoring of built env. at neighbourhood scale through a time machine operation of the platform.

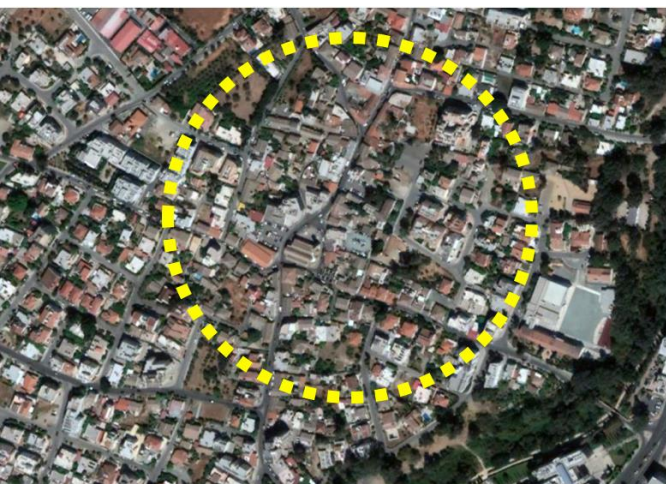


# Multi-layer scope of using digital tools for the study of built heritage



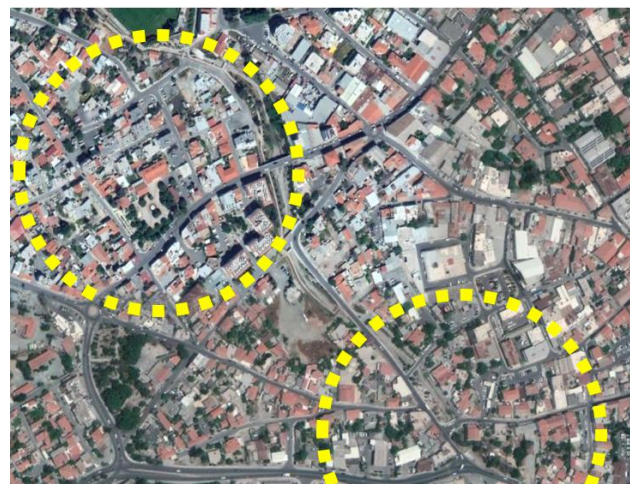
## Pilot building selection criteria:

- Architectural value;
- Historical value;
- Location;
- Typology;
- Condition;
- Ownership;
- Accessibility;
- Date of construction;
- Construction method;
- Construction material;
- Structural condition as result of climate, time wear and human interventions;
- Proximity to public service or landmark;
- Renovation state;
- Example of best practices.



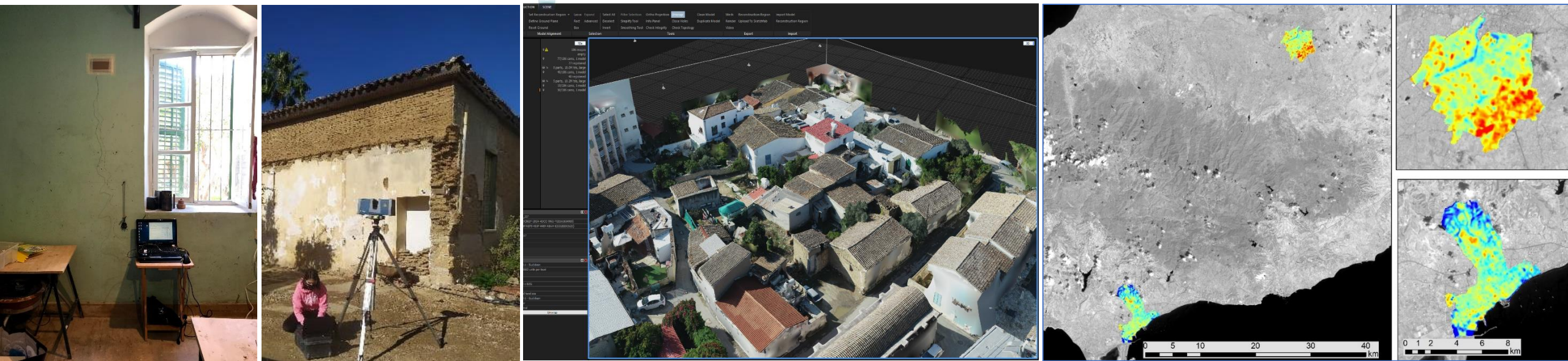
**1: Ten buildings in the Old Strovolos core district, Nicosia**

- (a) Reinforced concrete modernist structures;
- (b) Rural vernacular buildings of adobe or stone masonry;
- (c) Urban vernacular buildings of adobe or stone masonry.



**2: Ten buildings in old Limassol**

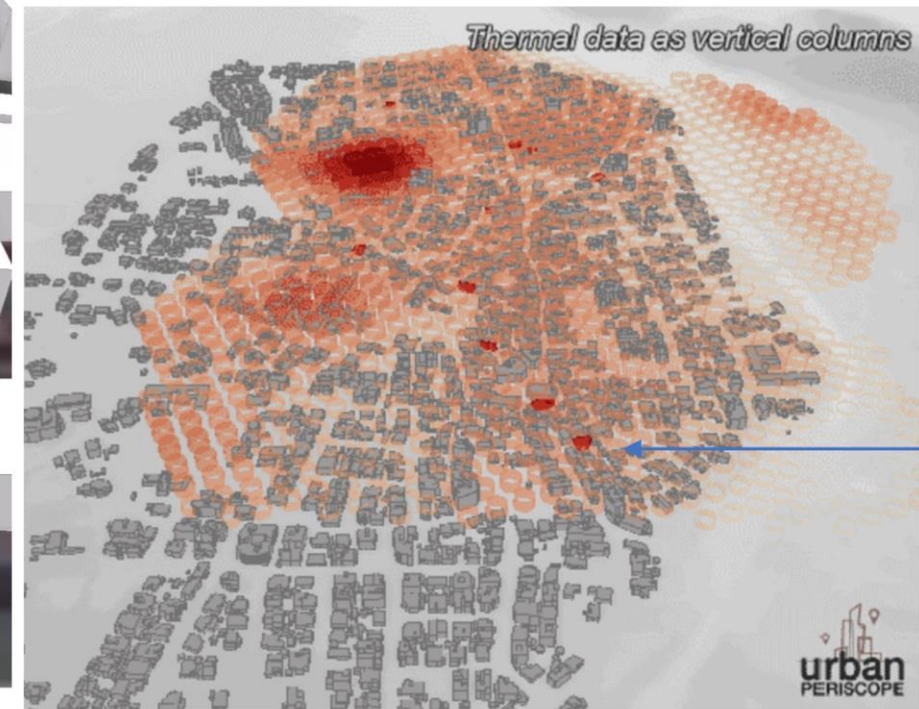




NDT at Strovolos pilot building. TLS 3D documentation. Aerial documentation of pilot building block at Strovolos. Surface temperatures over Limassol and Strovolos pilot areas

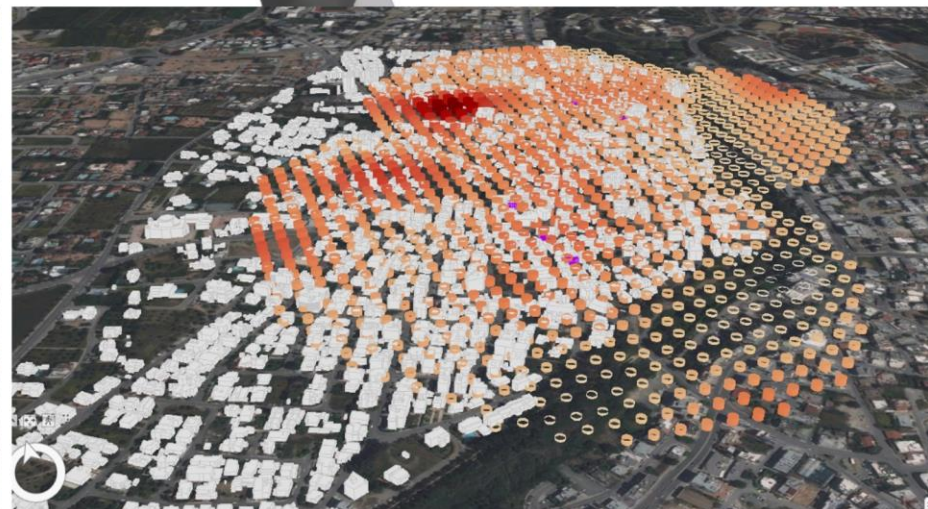
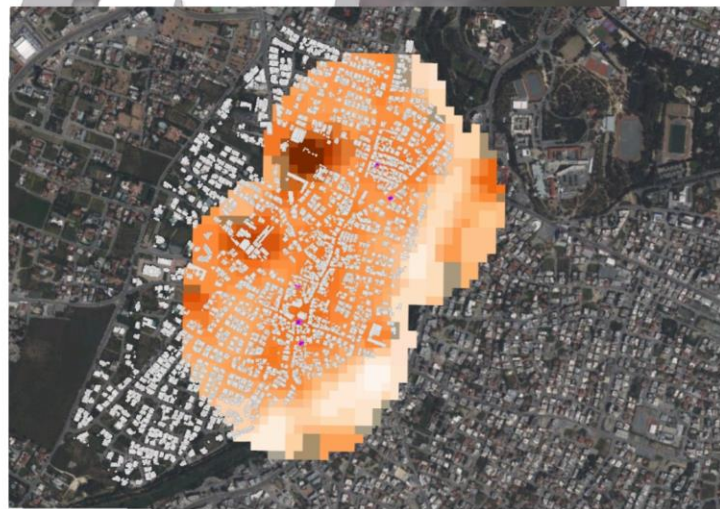


Online access to Digital Twins and environmental data at historic cluster scale.



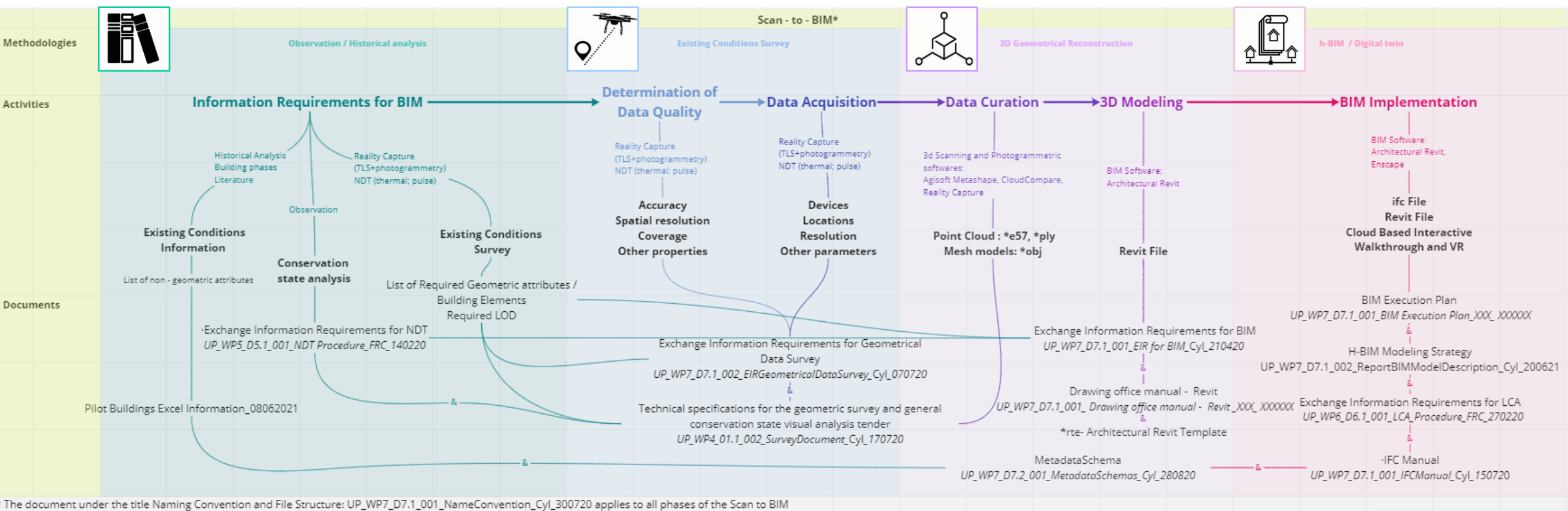
Pilot buildings

Dynamic exploration of surface temperatures in 3D GIS.



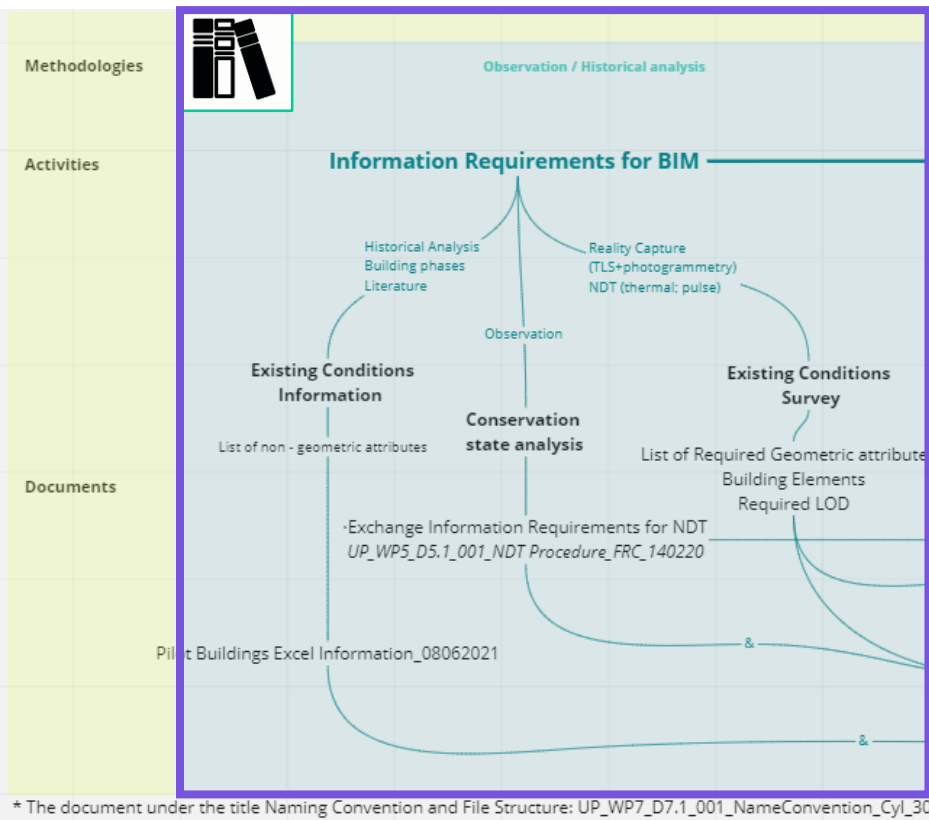


# Scan to H-BIM Process





# H-BIM Implementation



## Observation /Historical analysis

Building Identity Data Guide (WIP)

The purpose of the Building Identity Data Guide is to serve as a requirements guide in the collection of all the available data related to the identity of the case study building.

Exchange Information Requirements for NDT

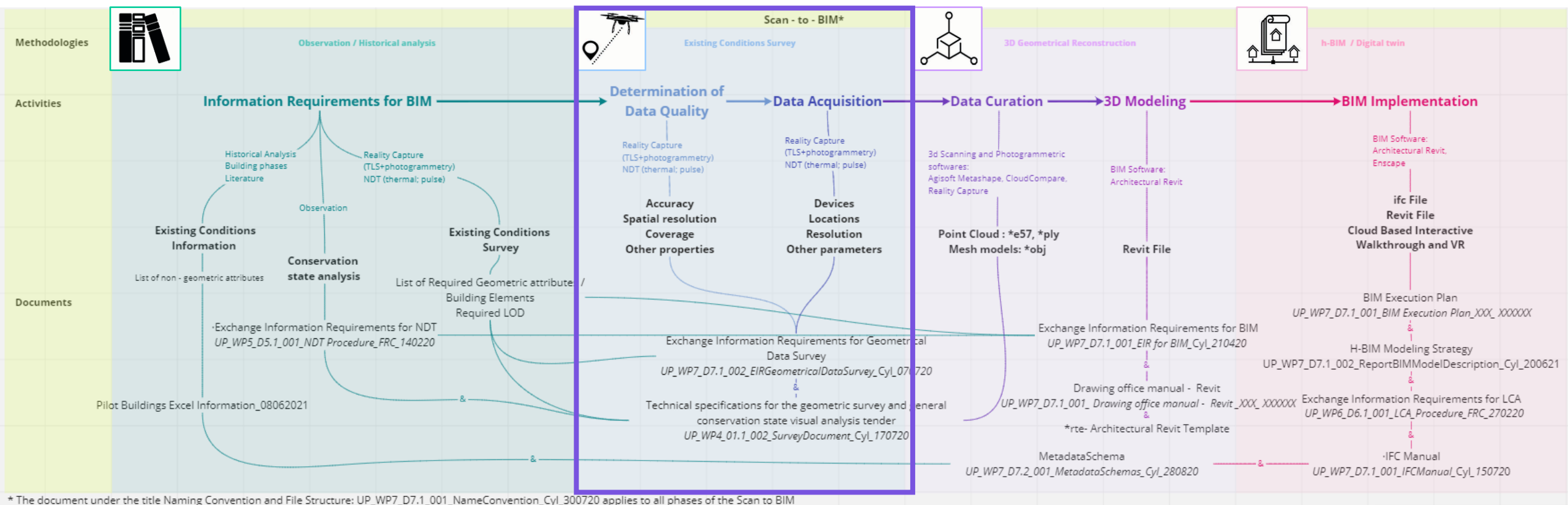
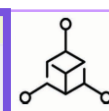
The purpose of these documents is to record the recommended process required for NDT and their derived deliverables. It provides guidelines for the NDT documentation techniques and evaluation criteria to ensure that the specified requirements for the deliverables are met the specifications of Scan to BIM standards.

List of Required Geometric attributes / Building Elements Required LOD (WIP)

The document provides a list of required geometric attributes to be captured during the existing condition survey phase as well as the required level of detail that should be captured.



# Scan to H-BIM Process

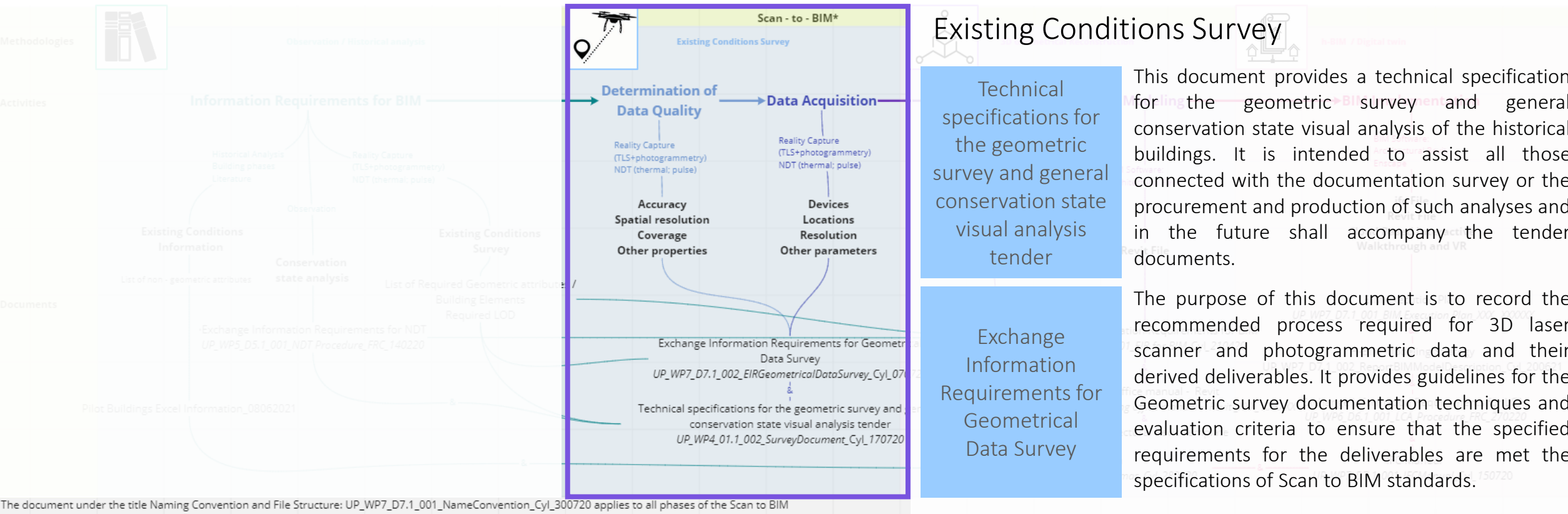


\* The document under the title Naming Convention and File Structure: UP\_WP7\_D7.1\_001\_NameConvention\_Cyl\_300720 applies to all phases of the Scan to BIM





# H-BIM Implementation



## Existing Conditions Survey

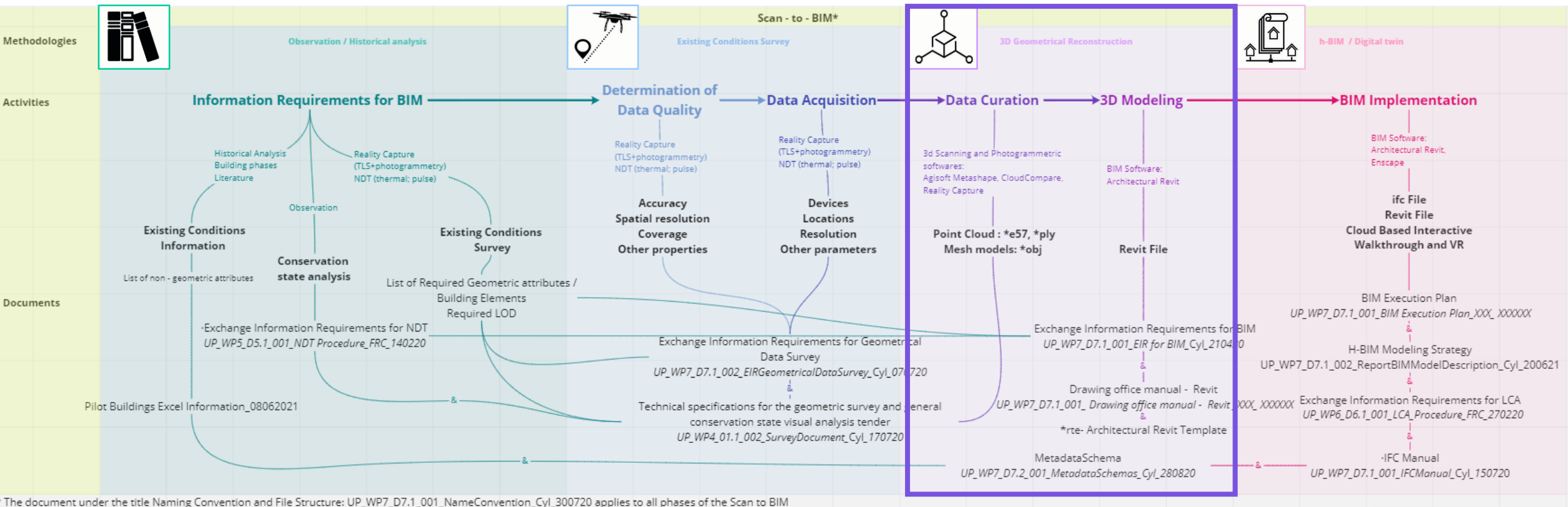
Technical specifications for the geometric survey and general conservation state visual analysis tender

Exchange Information Requirements for Geometrical Data Survey

This document provides a technical specification for the geometric survey and general conservation state visual analysis of the historical buildings. It is intended to assist all those connected with the documentation survey or the procurement and production of such analyses and in the future shall accompany the tender documents.

The purpose of this document is to record the recommended process required for 3D laser scanner and photogrammetric data and their derived deliverables. It provides guidelines for the Geometric survey documentation techniques and evaluation criteria to ensure that the specified requirements for the deliverables are met the specifications of Scan to BIM standards.

# Scan to H-BIM Process





# H-BIM Implementation



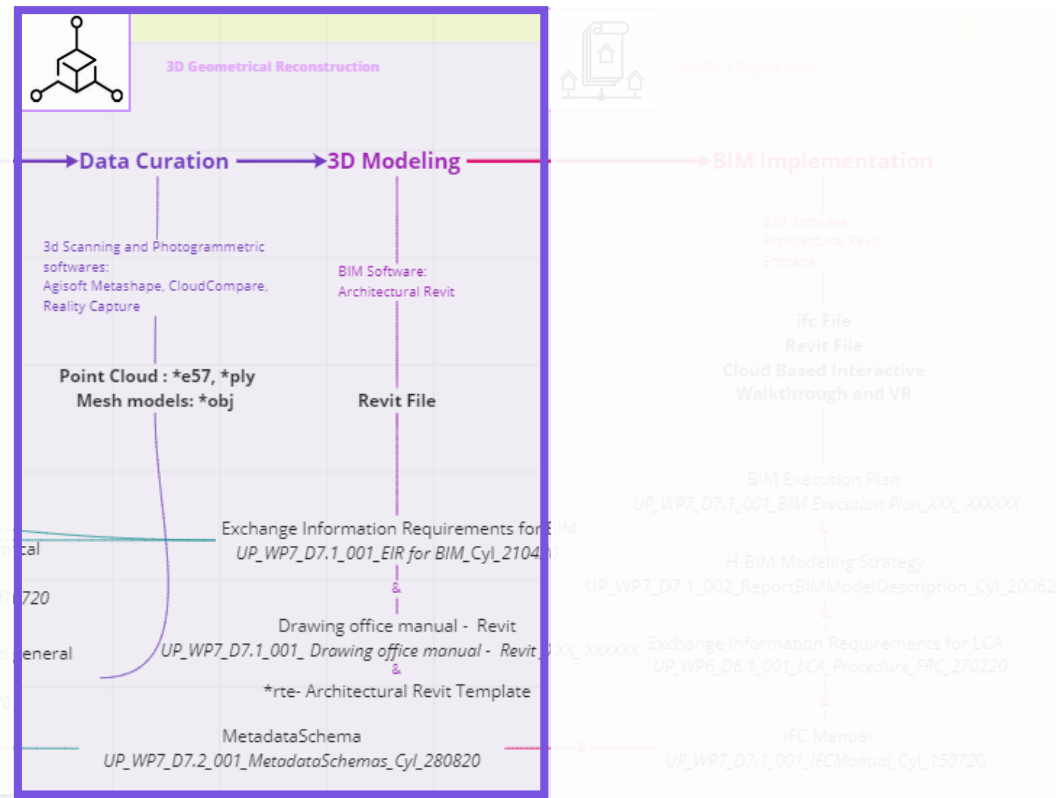
## 3D Geometrical Reconstruction

Exchange  
Information  
Requirements for  
BIM

The purpose of the EIR for BIM is to provide support and to serve as a requirements guide in the design of the buildings selected, according to the BIM model goals. This document focuses on data optimization, creating a hierarchy of the information (i.e., metadata linked with 3D assets), and explaining BIM with a clear methodology.

BIM Revit Technical  
Manual (WIP)

The BIM Revit Technical Manual provides all the technical details and design options required for the creation of an h-BIM model. The manual focused on the creation of all the components and materials, the specific component information which defines the various building features such as walls, floors, roofs, doors and windows as well as the generic assemblies to be assigned material properties.

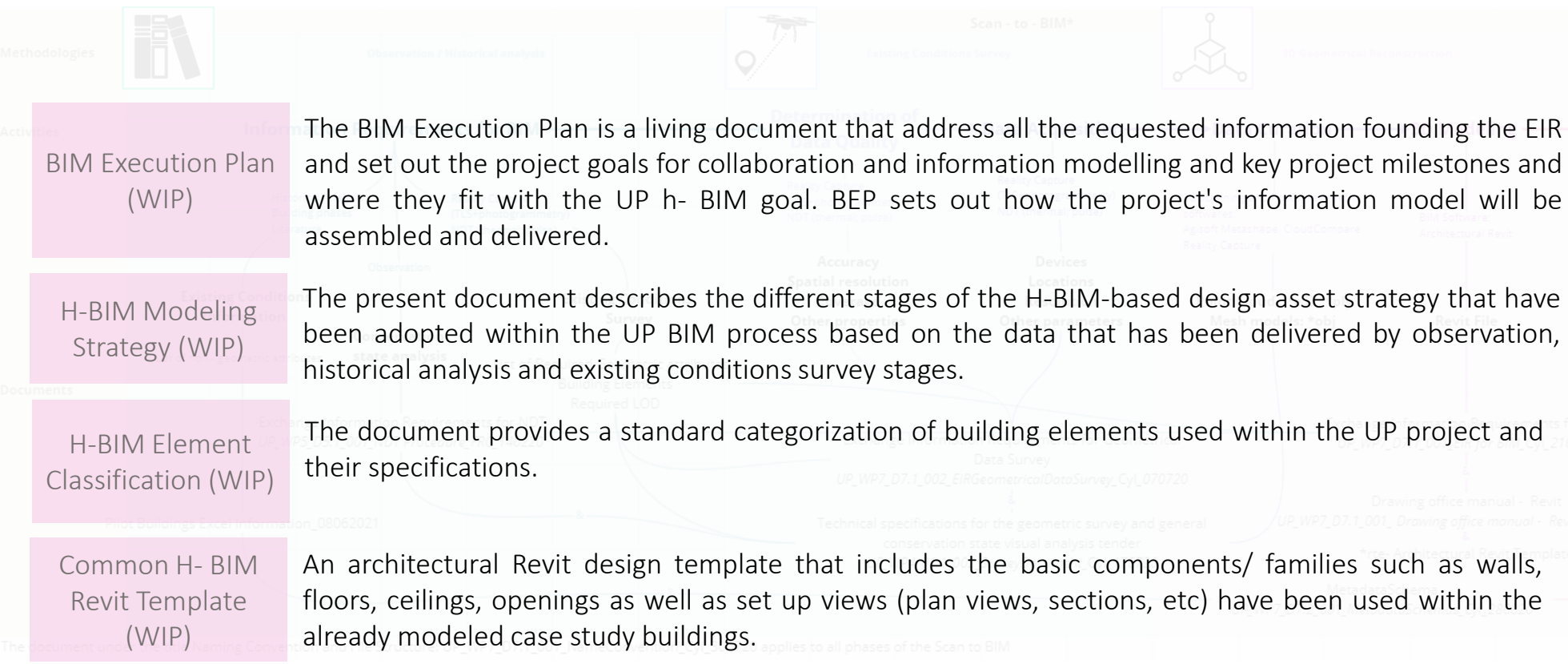


\* The document under the title Naming Convention and File Structure: UP\_WP7\_D7.1\_001\_NameConvention\_Cyl\_300720 applies to all phases of the Scan to BIM

# H-BIM Implementation



## h-BIM / Digital twin



BIM Execution Plan (WIP)

The BIM Execution Plan is a living document that address all the requested information founding the EIR and set out the project goals for collaboration and information modelling and key project milestones and where they fit with the UP h- BIM goal. BEP sets out how the project's information model will be assembled and delivered.

H-BIM Modeling Strategy (WIP)

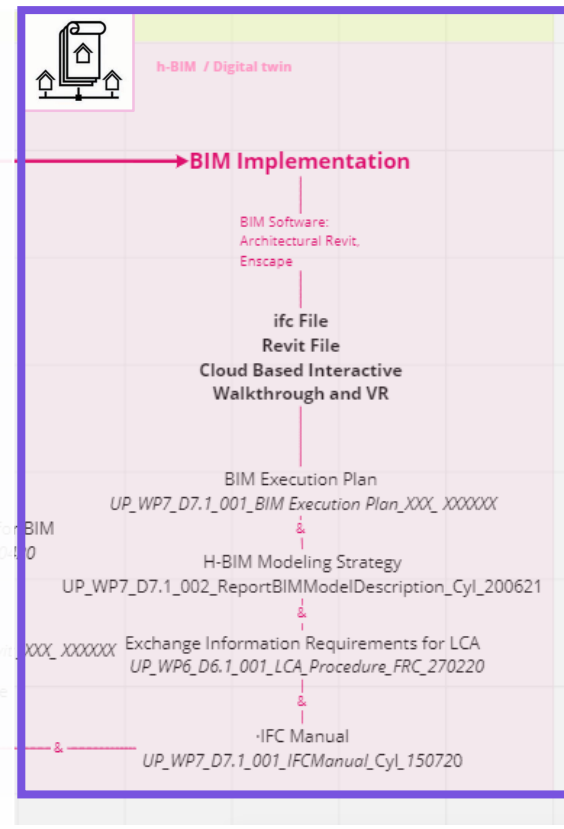
The present document describes the different stages of the H-BIM-based design asset strategy that have been adopted within the UP BIM process based on the data that has been delivered by observation, historical analysis and existing conditions survey stages.

H-BIM Element Classification (WIP)

The document provides a standard categorization of building elements used within the UP project and their specifications.

Common H- BIM Revit Template (WIP)

An architectural Revit design template that includes the basic components/ families such as walls, floors, ceilings, openings as well as set up views (plan views, sections, etc) have been used within the already modeled case study buildings.





# H-BIM Implementation



## h-BIM / Digital twin

### Metadata Schemas

A document that describes a series of metadata schemas such as bibliographic documentation or geoinformatics, that are required to be added to the BIM model in order to meet the specifications of a CIDOC CRM based on ISO standards ISO 21127:2014.

Checklist:  
H-BIM model  
(Revit), IFC File &  
H-BIM model  
export files (WIP)

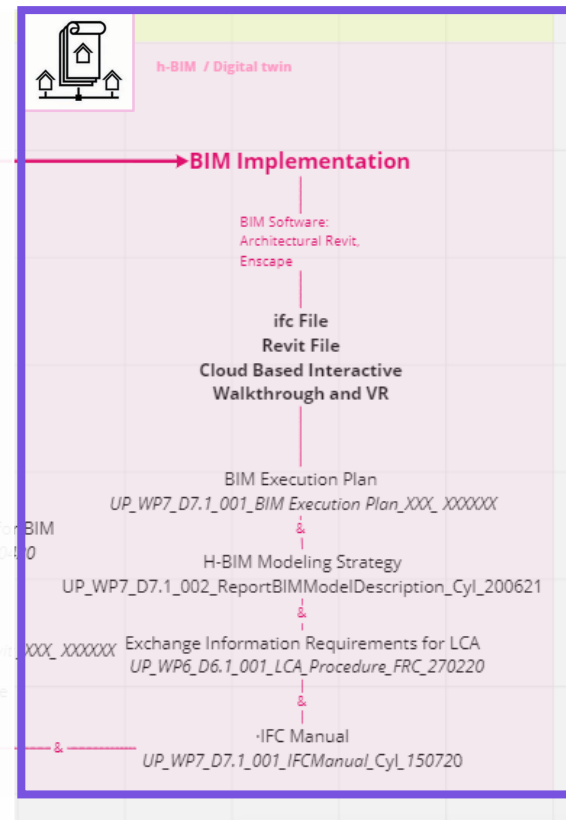
These checklists are intended to standardize the performance of all the repetitive activities that take place during the h-BIM design phase as well as to verify the correct BIM implementation.

### IFC Manual

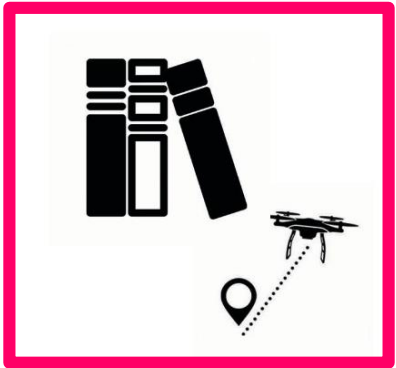
This document is intended to serve as a guide for UP BIM team, handling IFC data and providing a better understanding of the settings that are available within BIM software, discussing the way they can influence the quality and the content of IFC files.

Exchange  
Information  
Requirements for  
LCA

The purpose of these documents is to record the recommended process required for NDT and LCA and their derived deliverables. It provides guidelines for the LCA documentation techniques and evaluation criteria to ensure that the specified requirements for the deliverables are met the specifications of Scan to BIM standards.



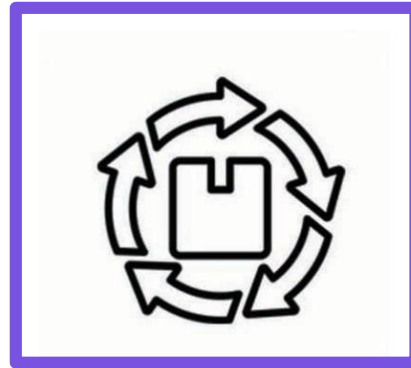
# H-BIM Modeling Strategy



Existing Conditions Information



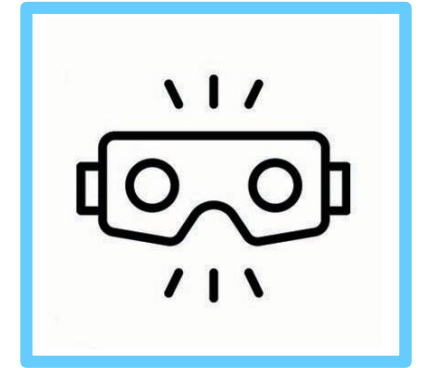
h-BIM



LCA

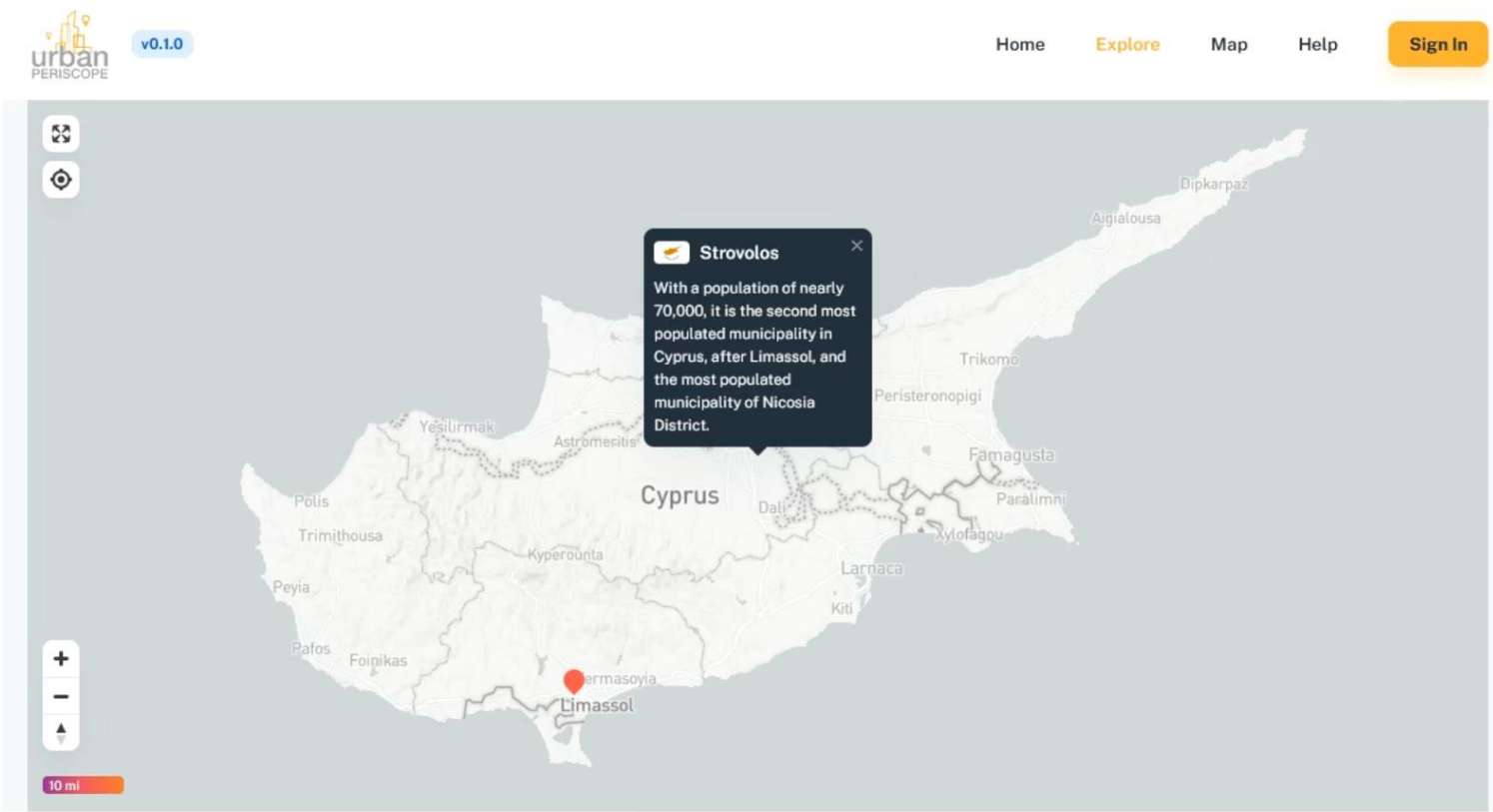


NDT



Interactive visualization





Period

☐ interwar

Historical Style

- ☐ neoclassical
- ☐ rural Cypriot architecture

Main Material

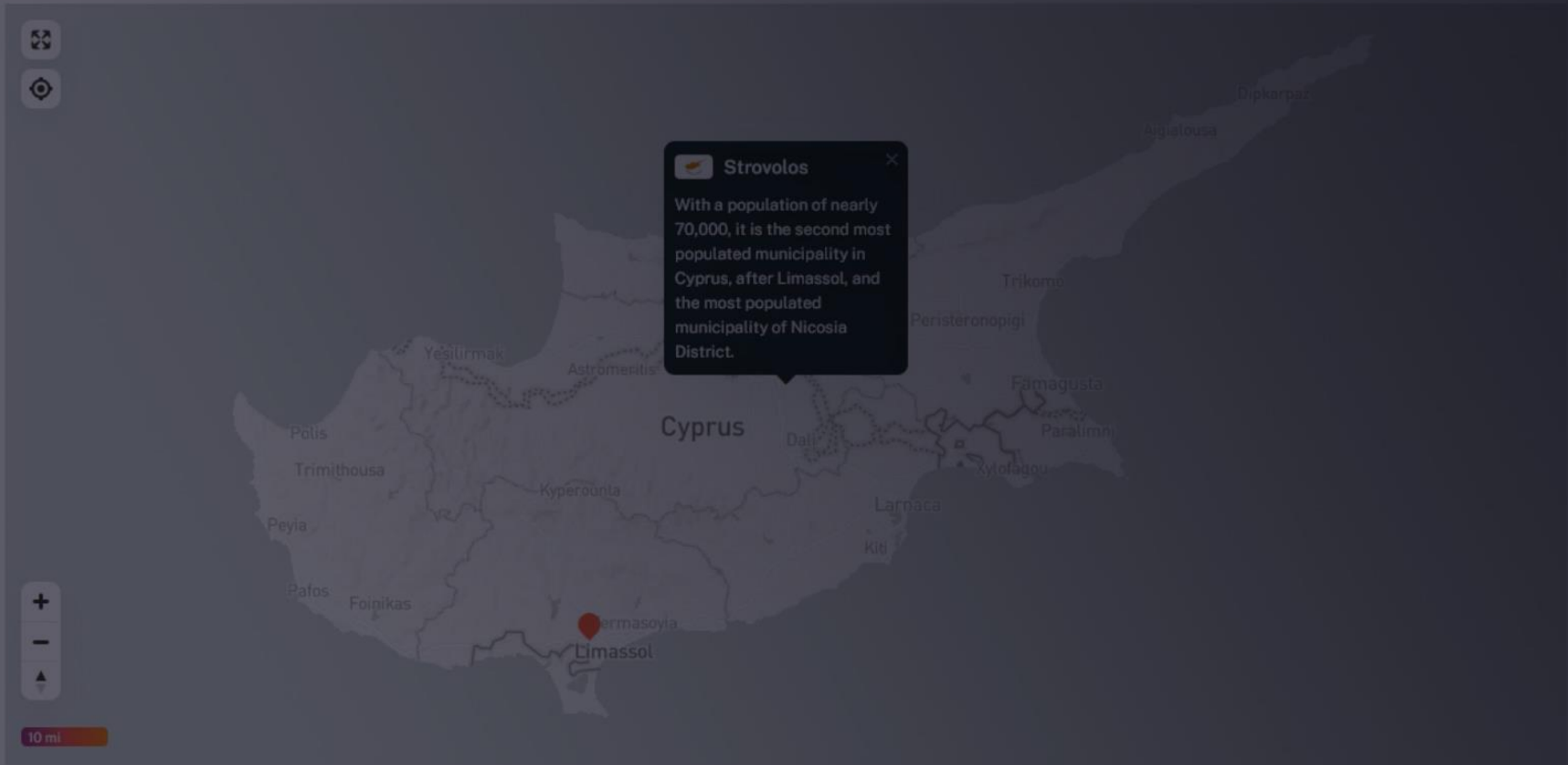
- ☐ sandstone
- ☐ adobe
- ☐ timber

Original Use

☐ residential

Current Use

☐ residential



Q Search building...

Filters Sort By: Featured



≡ Clear All



# H-BIM Modeling Strategy

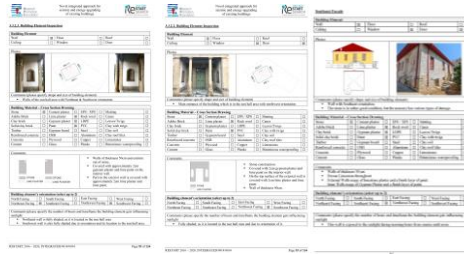


## INPUT

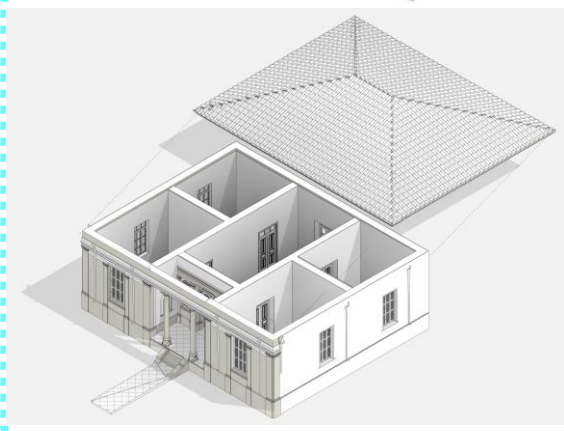
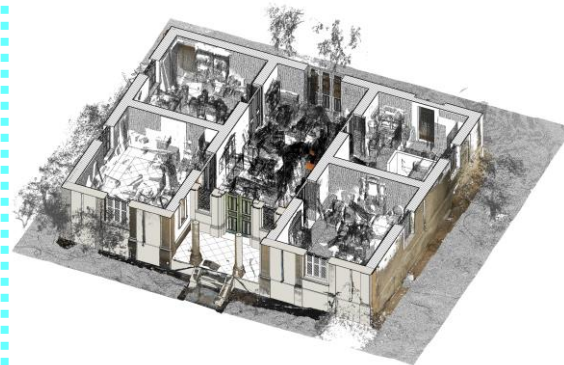
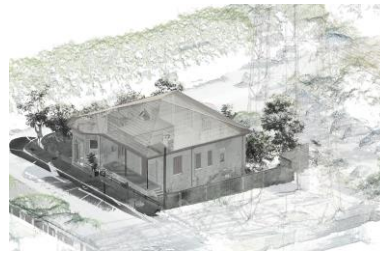
### Existing Conditions Information



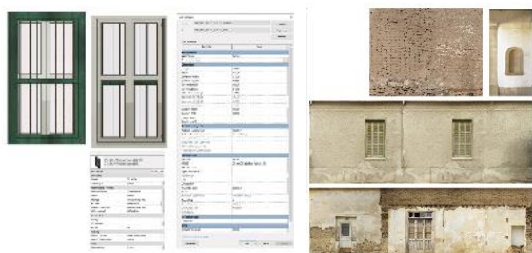
### Conservation state analysis



### Existing Conditions Survey



3D Geometrical Reconstruction of Cultural Asset

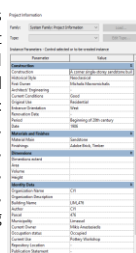


Families Generation / Classification & Material Composition



Structural and thermal condition integration with NDT

A series of project parameters are imported to Revit -Project information section as shared parameters to enrich the model with all the historical data: Construction, Current conditions, Owner, Original Use, Date, Period, Main material, Finishings, Municipality, Occupation Status, Repository Location, Listing Status etc.



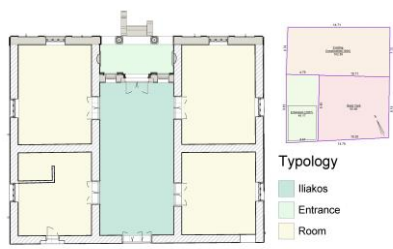
Historical Data Integration



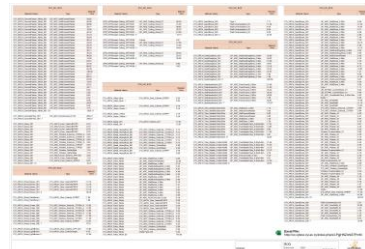
H-BIM Model- ifc file



2D drawings



4D typology



5D-BOQ

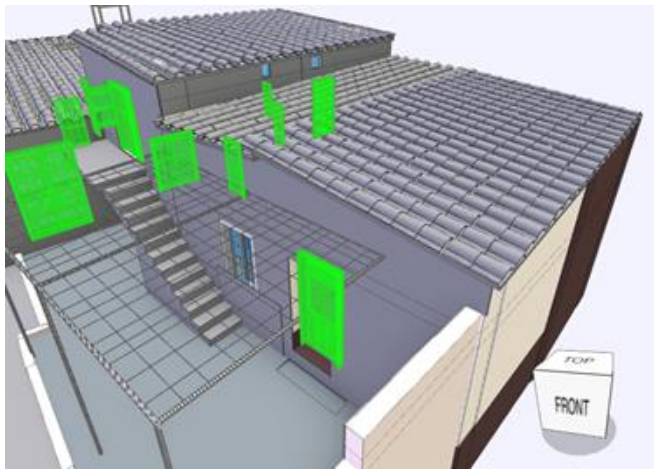
Life Cycle Assessment for Level(s) in compliance with EN 15978									
Result category	Global warming potential (kg CO <sub>2</sub> e)	Biogenic carbon storage (kg CO <sub>2</sub> e)	Cradle to gate carbon footprint (kg CO <sub>2</sub> e)	Acidification potential (kg SO <sub>2</sub> e)	Eutrophication potential (kg PO <sub>4</sub> e)	Formation of ozone layer depletion potential (kg CFC11e)	Abiotic depletion potential (ADP, elements kg Sb eq)	Total (kg CO <sub>2</sub> e/m <sup>2</sup> floor area)	
A1-A3 Construction in use	1,103	1,548.4	1,28-3	3,9962	3,9261	3,1811	8,103		
A4 Transportation to site	3,283	6,296-4	1,4283	3,180	2,038-4	2,2481			
A5 Construction in use	6,9513	9,768-5	2,463	2,760	2,3650	1,0350			
B1 Use Phase									
B3 Repair	0.00	0.00	0.00	0.00	0.00	0.00			
B4 B5 Material replacement and refurbishment	0.00	0.00	0.00	0.00	0.00	0.00			
B6 Energy use									
B7 Water use									
C1-C4 Total of life	1,5483	1,718-5	1,7683	1,760	1,6650	1,1800			
Total	1,2483	1,548.4	1,986-3	4,9912	4,9711	3,481	9,2713		

6D-LCA

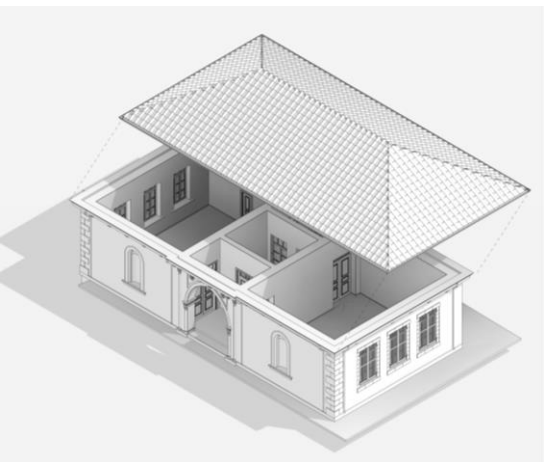


H-BIM - Digital twin

# H-BIM Modeling Strategy



\*ifc Files



\*rvt Files



IFC Export Classes: C:\ProgramData\Autodesk\RVT 2022\exportlayers-ifc-IAI.txt			Load...
Revit Category	IFC Class Name	IFC Type	Standard
Abutment Foundation Tags	Not Exported		Save As...
Abutment File Tags	Not Exported		
Abutment Tags	Not Exported		
Abutment Wall Tags	Not Exported		
Abutments	IfcSlab		
<Hidden Lines>	IfcSlab		
Abutment Foundations	IfcSlab		
Abutment Piles	IfcSlab		
Abutment Walls	IfcSlab		
Approach Slabs	IfcSlab		
Air Terminals	IfcAirTerminal		
Alignment Station Label Sets	IfcBuildingElementProxy		
Alignment Station Labels	IfcBuildingElementProxy		
Alignment Tags	IfcBuildingElementProxy		
Alignments	IfcBuildingElementProxy		
Analytical Beam Tags	Not Exported		
Analytical Beams	Not Exported		
Analytical Brace Tags	Not Exported		
Analytical Braces	Not Exported		
Analytical Column Tags	Not Exported		
Analytical Columns	Not Exported		
Analytical Floor Tags	Not Exported		

Modify Setup	
<In-Session Setup>	
<IFC2x3 Coordination View 2.0 Setup>	
<IFC2x3 GSA Concept Design BIM 2010 Setup>	
<IFC2x3 Basic FM Handover View Setup>	
<IFC2x3 Coordination View Setup>	
<IFC2x3 COBie 2.4 Design Deliverable Setup>	
<IFC4 Reference View [Architecture] Setup>	
<IFC4 Reference View [Structural] Setup>	
<IFC4 Reference View [BuildingService] Setup>	
<IFC4 Design Transfer View Setup>	
General	Additional Content   Property Sets   Level of Detail   Advanced
IFC version	IFC 2x3 Coordination View 2.0
Exchange Requirement	
File type	IFC
Phase to export	Default phase to export
Space boundaries	None
Coordinate Base	Shared Coordinates
Projected Coordinate System Reference	
Name	Eastings
Description	Northings
EPSG Code	
Geodetic Datum	
Reset	
File Header Information...	
Project Address...	
Reset	
OK	
Cancel	

## IFC Manual

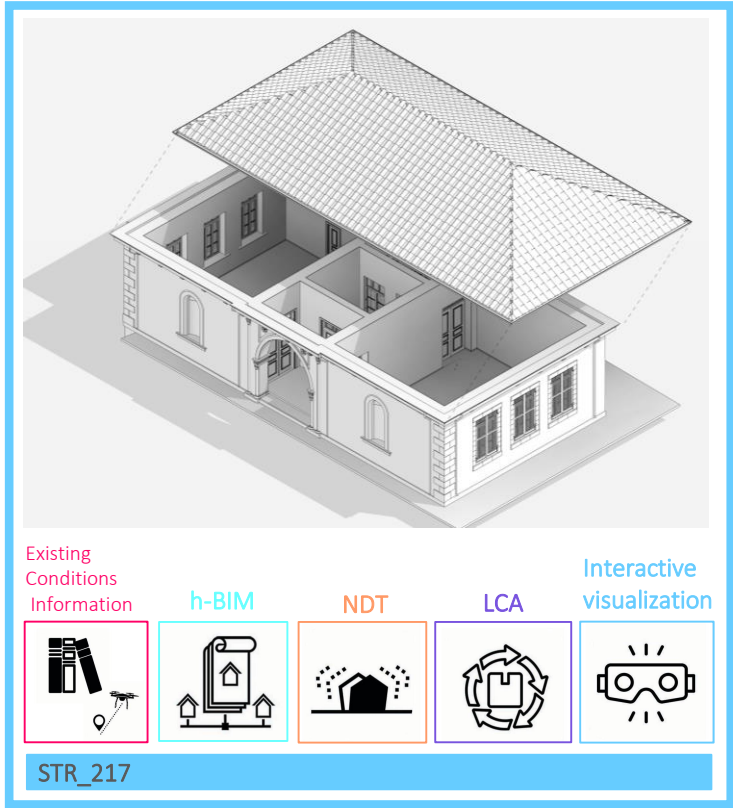
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U-Periscope  
Platform



U-Periscope Platform

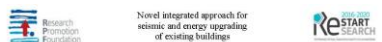
Checklist:  
H-BIM model (Revit),  
IFC File &  
H-BIM model export files (WIP)

These checklists are intended to standardize the performance of all the repetitive activities that take place during the h-BIM design phase as well as to verify the correct BIM implementation.





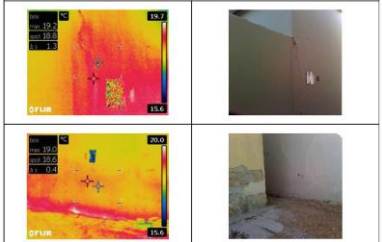
## Non-Destructive Testing



Comments (please specify the number of hours and timeframe the building element gets influencing sunlight)

- Exposed to solar radiation during sunrise only on a small surface of the wall.
- Exposed to solar radiation the entire wall approximately at 11 in the morning for about 1 hour.
- Mostly shaded due to proximity with neighbouring building.

Visible voids and cracks



Comments (please specify location on building element, type, shape and size of void/crack)

- Moisture build up can be observed at the lower part of the wall, similar to the rest of the building's walls.
- Crack at the joining point between building's wall and fence wall.

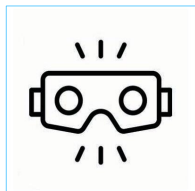
Property	Value
Surface temperature of building element [°C]	
Ambient Temperature [°C]	
Indoor Temperature [°C]	
Humidity levels of building room [Pa]	
Emissivity of building element [°C]	
Reflected temperature of building room [°C]	
Negative pressure (VSS-Nb)	
Conditions (hour, solar exposure)	

Comments (if yes, please specify the conditions under it is created and the differential pressure in [Pa])

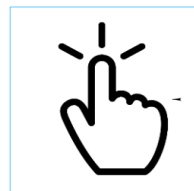




Digital Twin



\* Exe file



Web browser link:

<https://api2.enscape3d.com/v1/view/0a12d3c8-95d8-4656-b3a1-39c026d388ed>



- Project email: [info.UPeriscope@cyi.ac.cy](mailto:info.UPeriscope@cyi.ac.cy)
- Project website: <http://uperiscope.cyi.ac.cy/>

The Project PERIsCOPE INTEGRATED/0918/0034 is co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research Innovation Foundation.



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