D.T.2.2.1.
STATE OF THE ART AND MONITORING SYSTEM
REQUIREMENTS FOR RISK MANAGEMENT, REUSE, ENERGY PERFORMANCES

PP7 SPECTRA

VERSION 1

01 2018

INDEX

FOREWORD

BRIEF INTRODUCTION TO THE NEEDS (WHY MONITORING)

The role of monitoring is as one component of management. According to the UNESCO Recommendations, monitoring is assumed as a necessary and sufficient condition for programming, obtaining through direct observations, useful information to predict, and then to decide in advance. The term "monitoring" has its origin in the industrial field, indicating the continuous control over a machine in operation, using special instruments that measure the characteristic parameters like speed, consumption, production, etc. (UNESCO, 2015; Ciocia, Napolitano, & Viola, 2013).

For this project, the monitoring in HBA can be explained as the continuous controlling process over selected historic structures in transformation, aimed at structural and functional indicators using ICT tools.

Monitoring involves assessing the condition of the historic area and may lead to recommendations that outline the requirements for conservation and to management activity that results in work carried out. Monitoring is essential to understanding a problem before any remedial action is attempted (Department of Conservation, 2003). This work can be an investment in the future management of the historic urban area. Decisions must be based on detailed knowledge about relevant territory.

A monitoring system in HBA depends on specific conditions due to reasons for monitoring. It is important to follow defined main interests and objectives (strategic approach). The goal is to get data that will be evaluated contextually and show potentials, key problems, and differential comparison.

The following questions are important for setting up the monitoring system:

- What are the main interests in monitoring?
- Which data is needed to collect?
- Which data are already available in the area of interest (geometrical survey, shapefiles, GIS database, etc.)?
- What are possibilities for data collecting?
- Who is responsible for data collecting?

The Austrian meeting is crucial for the development of T1 and T2 activities, we will have the occasion to find a common view on the final outputs of these technical work-packages and define a work-plan for 2018.

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CHAPTER 1

WHAT IS POSSIBLE TO MONITOR

If objectives for monitoring are known, it is possible to proceed with the selection of data, which will be monitored. Every data must have a purpose. It helps to avoid unnecessary data. A selection has to note the relevant interests for certain HBA. The focus must be on indicators that can change their value.

Monitoring data can be divided into three groups:

1. Basic data - the main data, which includes information about usage
   For example Current use, Build area, Ownership (public, private), Legal protection, Population, …

2. Building condition data
   For example Condition of Roof, Condition of Exterior, Condition of Interior, Age/construction period, Materials, Style, Elevation/height, Building volume/ Floor area, …

3. Data linked to sustainability components (defined in D.T.2.1.1). Each PP should choose a set of data that is relevant to a defined interest. Examples are in this table:

Geometric data on the monitored area or buildings are an obvious need for the monitoring.

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GROUP	*COMPONENTS AREA OF INTEREST*	*EXAMPLES OF DATA, WHICH CAN BE MONITORED*
ENVIRONMENT	Energy efficiency	Insolation, used materials, energy consumption (total, per m3), thermovision measurements ...
	UHI	Insolation, urban greenery (a type of vegetation, greenery index in the block), temperature, thermovision measurements,
	Waste and water	flood risk, groundwater,...
	Pollution	Air pollution, noise intensity, ...
	Mobility	transport accessibility, traffic intensity, ...
SOCIAL	Services and facilities	description of the use of objects, ...
	Cultural life and leisure facilities	description of the use of objects, ...
	Identity perception	mental maps, landmarks, ...
	Gentrification vs. mixitè	Accessibility of services, …
	Accessibility	Accessibility for the disabled, ...
	Security	The occurrence of natural disasters/man-made risks, type of risks, accessibility for emergency services...
ECONOMY	Tourism impact	Importance of interesting points, number of visits, events, ...
	Maintenance costs	energy kw / m2/3 , ...
	Transformation costs	A number of transformed objects, …

CHAPTER 2

ACTIVE PARTIES IN MONITORING (WHO MONITORING)

A wide range of stakeholders influences changes in HBA, and conversely these changes influences them. This leads to increased interest in tracking changes. There is a need for monitoring and for cooperation.

Municipalities as local authorities are main actors in HBAs, which involve and cooperate with other stakeholders. In the monitoring process, their role is to coordinate monitoring activities.

Heritage-based and interested organizations must be involved in monitoring, especially as providers of some data about the area.

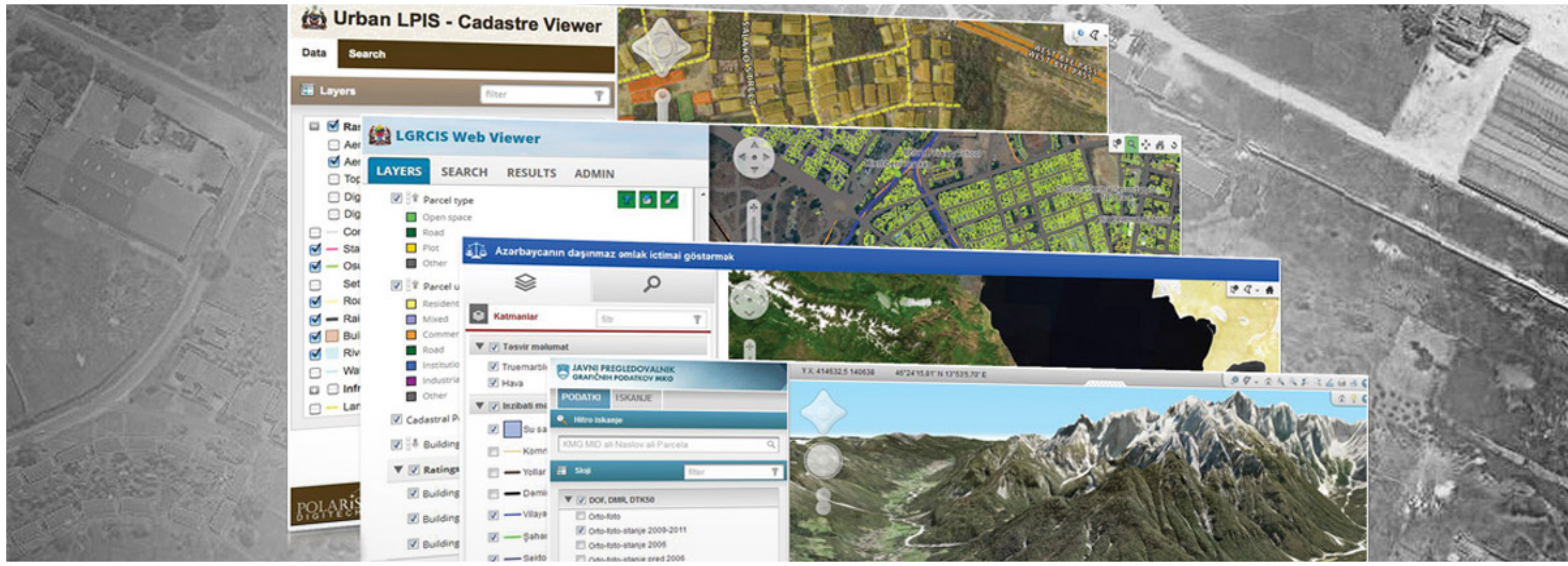
Owners, inhabitants, visitors and other similar stakeholders in the area can be involved in monitoring ad hoc.

Other public is in the role of the viewer.

For data collecting are used **field workers** and for data processing are used some **professionals** for example on GIS or BIM.

CHAPTER 3

POSSIBILITIES FOR MONITORING (HOW MONITORING)



If we know reasons, interests, and objectives of monitoring, then next step is to define monitoring process as a set of procedures.
This process could be divided into main parts:

1. data collecting
2. data processing and analyzing
3. data sharing

The completeness and incisiveness of monitoring activities are related to (Ciocia, Napolitano, & Viola, 2013):

- sources of knowledge taken into account;
- the frequency of data acquisition and analysis;
- parties involved in the various monitoring activities
- to find tolerance ranges and the threshold level

4.1 Data collecting

Data collecting as the first step in monitoring may use these methods:

- data survey including desk research, collecting existing data and historic records (archeological records, historic plans, ...)

- creating and completing forms or standard checklists based on site visit, familiar information, recorded observations, photographs,

- acquiring new necessary data through measurements, sensors, remote sensing, ...

- crowdsourcing (to involve stakeholders)

Generic statistical or indicative analysis of the urban area is not sufficient. Detailed analysis of the area is time-consuming and requires professional expertise to identify specific elements that contribute to the sustainability of the historic urban environment (Getty Conservation Institute, 2009). Monitoring methods should be applied at a specific scale. According to Department of Conservation from New Zaeland (2003) different levels of survey and monitoring in historic areas may be recognized:

• Small-scale plan. Monitoring confined to the acquisition of a range of data at a fairly superficial level and with very limited potential for measuring gradual medium or long-term change.

• Medium-scale plan of a place and all components, but without detailed plans of each component. Good potential for monitoring medium-term change across the site but limited usefulness for recording changes to individual structures.

• Large scale plan including details of place and all components (scale of site plan normally better than 1: 500.) Good potential for monitoring medium and long-term change across the site and individual components.

For built structures, there is again a range of levels of documentation. There is no single best way to record a standing structure, but ground, floor, and roof plans together with elevations and sections are usually required to adequately record condition.

All sites require some degree of condition monitoring in order to determine the rate and causes of any deterioration, to establish if any negative visitor or management impacts are occurring, and indicate where intervention may be necessary (Department of Conservation, 2003). The more accurate information on existing objects may lead to an optimal design of monument restoration.

The periodicity of monitoring is a next aspect that must be taken into account. It is not generally possible to determine how often every HBA should be monitored. The frequency depends on the nature of monitored data and on the organization, which is responsible for monitoring. However, rules for periodicity must be specified. These rules can be divided into:

• Strict periodicity – short-term or long-term fixed cycles (it can be linked to local strategy or development program)
• Ad hoc – based on needs (e.g. new planned activity in area) or milestones (e.g. before and after intervention)

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4.2 Data processing and analyzing

An important component of any monitoring programme is to provide analysis and reporting of the information as well. Some collected data may be used in aggregate to report on the overall state of historic structures.

Therefore, new analytical tools and concepts are needed. These tools would enrich and expand the traditional methods and achieve sustainability of cultural heritage in any urban context.

Currently, modern digital technologies that can provide clear information on the condition of the historic urban area, or identify vulnerabilities and can be used to measure and register change and to process comparative analyses (Getty Conservation Institute, 2009). In spatial management are used tools such as Geographical Information Systems (GIS) and Building Information Modeling (BIM) is used. This is due to the ability to link spatial and non-spatial data of physical features, which can contribute substantially in documenting different urban features and in modelling processes in the

monitored area (Giannopoulou, Vavatsikos, Lykostratis, & Roukouni, 2014). *"A geographic information system (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps" (ESRI, 1997).*

"BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure" (Autodesk, 2017).
These technologies require relevant input data about monitored area or building including a great range of geometric and descriptive information (attributes). Great range of geometric and descriptive information can be used for the interpretation, monitoring, visualization, and evaluation of urban heritage areas. Detailed analysis of HBA leads to evaluation, which should be represented visually on maps and models that illustrate current situation, as well as the need for action.

4.3 Data sharing

In today's society, access to data and information is an important element. Access to information is important for stakeholders in the area and can lead to better understanding of needs and to adopt the development strategy as a common interest.

Tools like GIS and BIM allow presenting information in an advanced digital form. Interactive maps and models can provide more information and in a faster and more attractive way than long texts or traditional raster formats.

Spatial data processed in GIS can be visualized on the web via WebGIS technology. WebGIS is a web mapping application that allows publishing, viewing and browsing spatial data. Proper data processing is crucial for the quality of WebGIS. The aim is to provide comprehensive information that is easily accessible and simplifies the process for obtaining the required information. An important advantage is the ability to add data from different sources.

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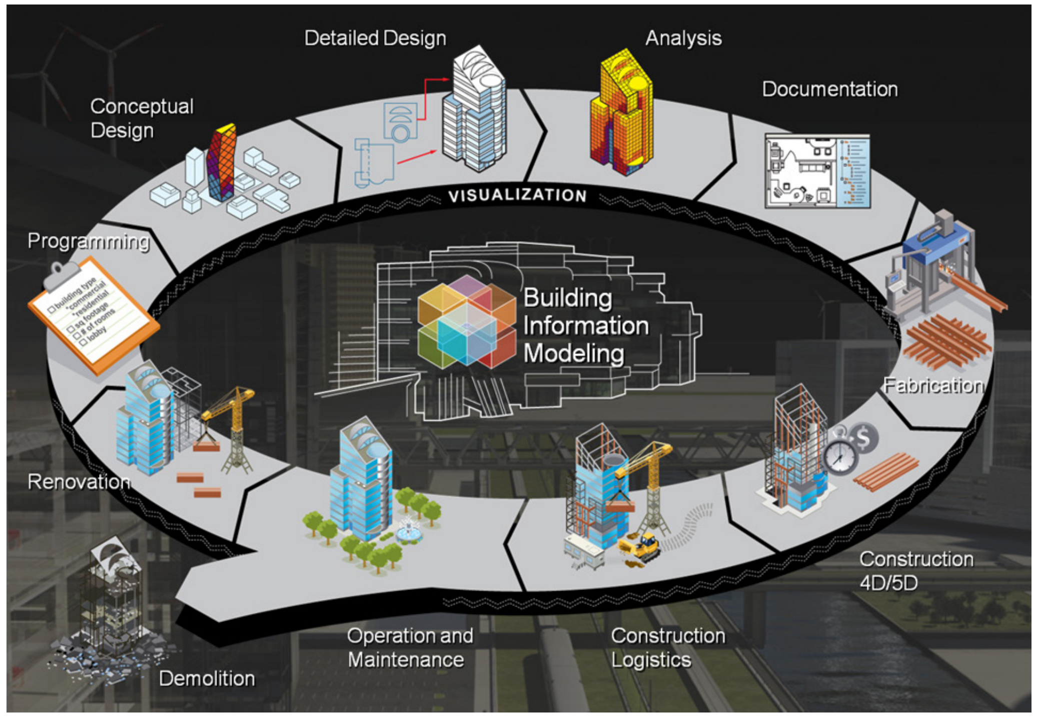
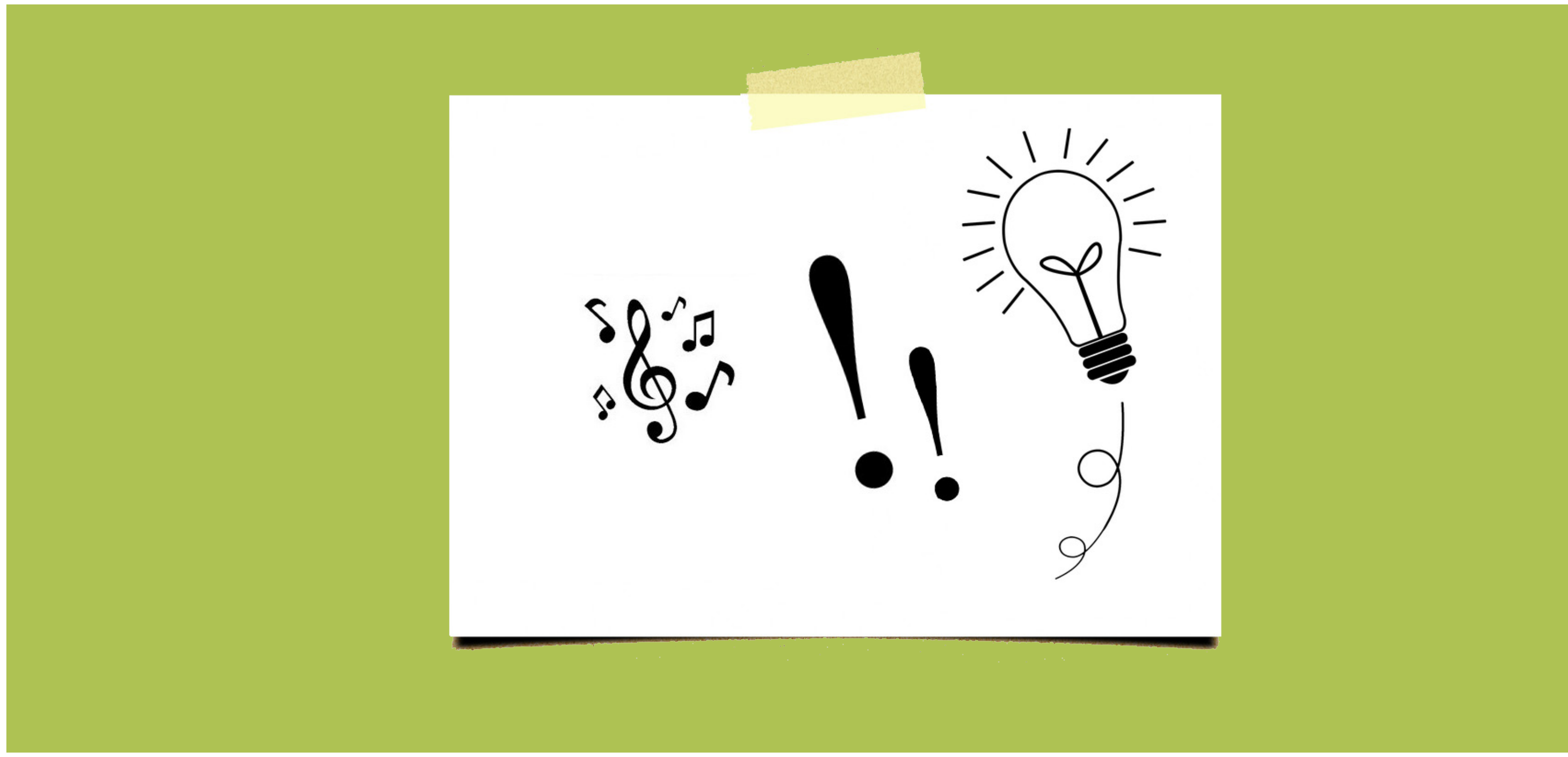
Next opportunity for spatial data sharing is to publish it in the way of open data. As open data can be published data in shapefile format (.shp), in geodatabase (usually .gdb), in format for Google maps (.kml or .kmz) or in format based on the JavaScript Object Notation (GeoJSON). This data should respect Directive 2007/2/EC, an EU initiative to establish an infrastructure for spatial information in Europe (INSPIRE) that is geared to help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development.

Data processed by BIM technology can be published on the web via BIM portal. The BIMportal is a collaborative working tool for multiple stakeholder engagements on a BIM project. For example, software called The BIMportal is an open source software under MIT license shared through GitHub as free. Common directive for BIM data sharing does not exist. The most used formats for BIM projects are .rvt or .dxf.
However, the common aim for data sharing is to deliver information, not raw data.



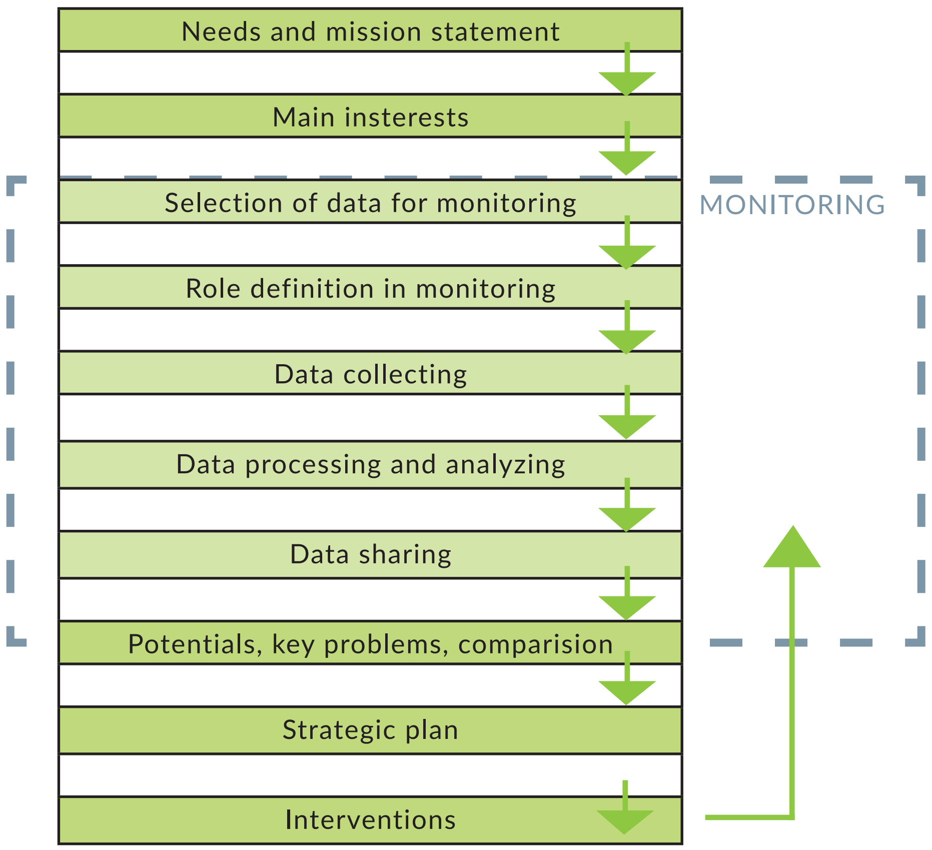
CHAPTER 4

IMPORTANT NOTES



Main principles for monitoring can include:

- Preparation for collaboration – municipality, related institutions, and general public
- To allow a development of databases in the future
- Periodicity – short-term, long-term, ad hoc
- Long-term view (ex-ante)
- Valuation



Picture 1: *Monitoring in the planning process*

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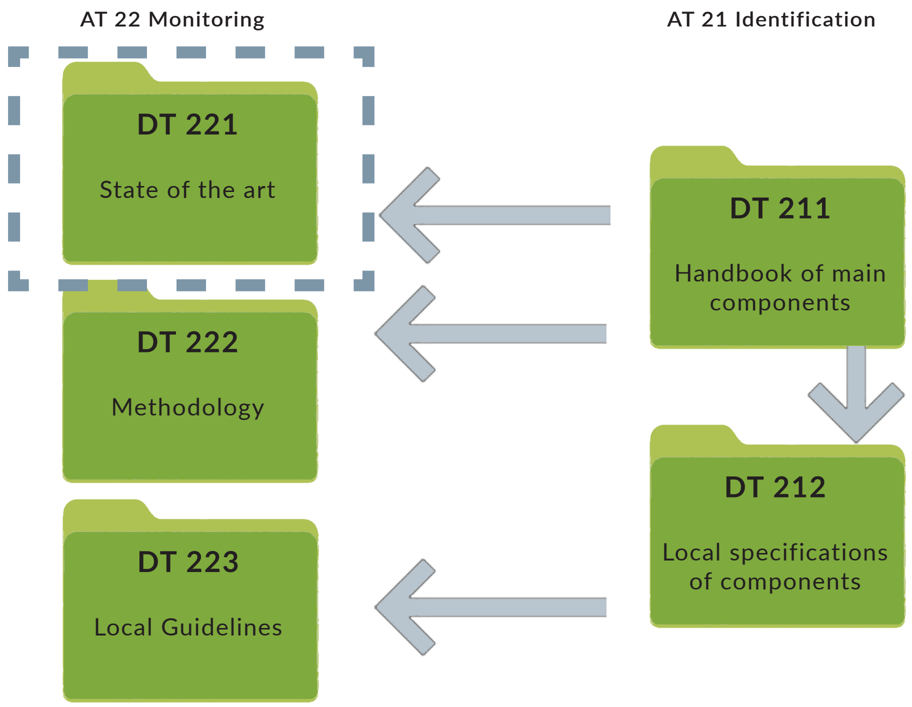
The output of monitoring should provide clarity for all users and explain why some actions are needed. The key is information that demonstrates the role of conservation in helping local governments to meet their sustainability agendas and targets.
The position of monitoring in the planning process is illustrated in the picture below.

Relations between some deliverables within thematic work package 2.

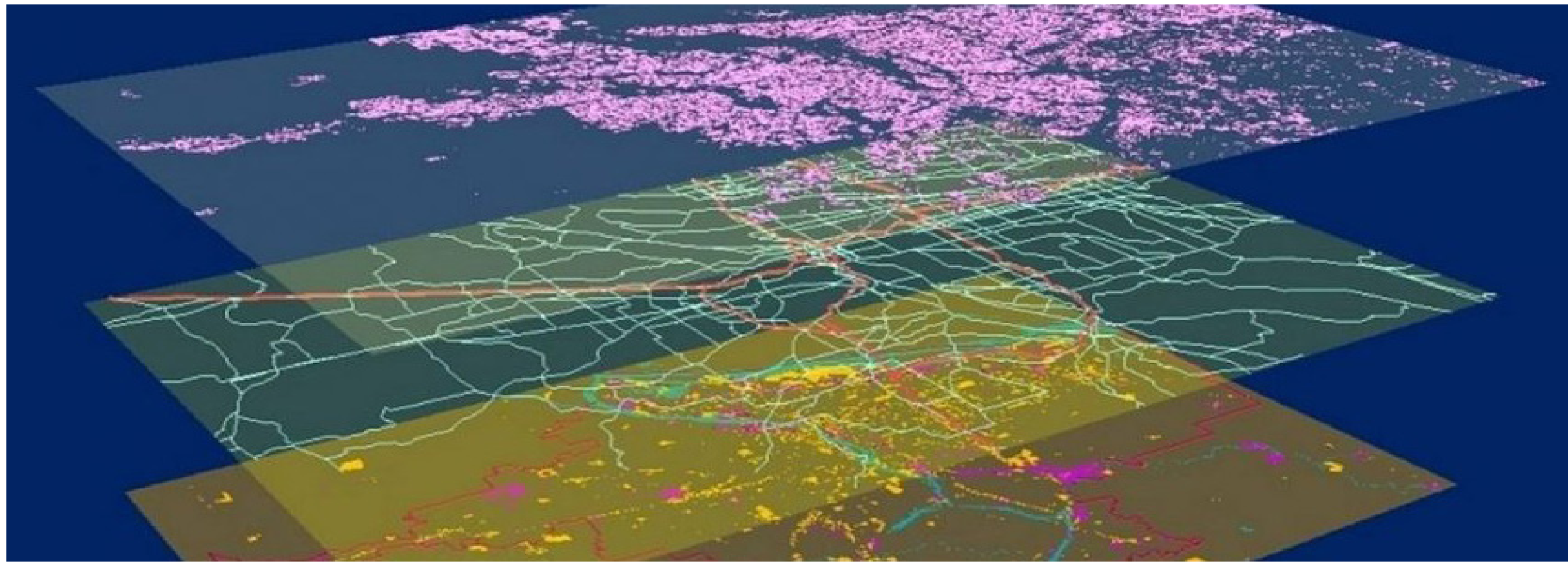
Deployment of instruments and tools is illustrated in picture 2.



Picture 2: *Relations between relevant deliverables*

CHAPTER 5

CASE STUDY



6.1 BIM - Example of pasportizing objects in Sliač (Slovakia)

For the analysis of the current conditions of buildings, passportization was carried out. Accurate information leads to a better renovation of the building. An important point of view is also on maintenance costs or transformation costs. The purpose is not only to create a 3D model but a model that contains a set of information about individual elements of the building.

The digital object with information about the materials was used for:

1. Hygienic model: simulation of work with space linked to the building layout/architecture

2. Technological model: spatial coordination of technological units and pipelines in a collision with building substance is immediately readable

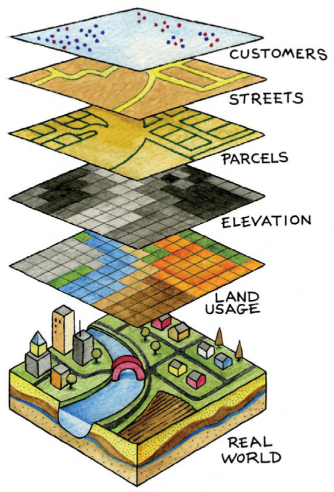
3. Energy Model - The information model has an identified geographical location, marginal conditions, and physical properties of the circumferential shell. So it is possible to know the energy conditions of the object practically with one click. It is possible to simulate different energy conditions in virtual design eg. a heat source, or a change in the physical properties of the peripheral structures and fillers.

In this case, modified facility management can save more than 5% (BIMAS, 2016).

6.1 GIS - using GI to record and analyse historical urban areas - Xanthi (Greece)

The case study of the paper is the Old Town of Xanthi, one of the most important examples of the 19th century's urban civilization in Northern Greece. The paper focuses on the elaboration of the data concerning the built environment and more precisely to its systematic retrieval and import to the GIS system; moreover, it examines 17 chosen variables using a combination of Multivariable analysis methods (Correspondence and Hierarchical Cluster Analysis). The analysis has shown the existence of four distinctive and very interesting groups which have their own specific characteristics. Ideas for further research include the collaboration with specialized sophisticated software which would facilitate the thorough examination, analysis, and correlation of parameters involved, towards the principles of sustainable and smart city development.

The creation of the specialized GIS was based on the structure of the existing GIS that had been created to cover the needs of the aforementioned Plan and Program. The existing GIS included geometric information (blocks, lots, buildings, streets etc.) and very limited descriptive information that specified only a few properties of the objects (mainly from the urban analysis), without covering the full range of the collected primary data the majority of which was not coded, while a wide detailed field recording is ongoing. Therefore, the full data retrieval and its systematic recording at the new redesigned database were considered necessary, combined with the



application of suitable transformations in order to fit the current National Reference System and to allow comparisons with up to date data. The present paper focuses on the elaboration of the data concerning the built environment and more precisely its systematic retrieval and import to the GIS system; moreover it examines 17 chosen variables using a combination of Multivariable Analysis methods (Correspondence and Hierarchical Cluster Analysis) (Markos et al., 2010) for the data interpretation and evaluation.

The analysis of the built environment was based on detailed fieldwork

Picture 3:
List of variables in database.

CODE	VARIABLE	CLASSIFICATION
XX1	Block Code	1-76
XX2	Ownership type	Private, Public
XX3	Construction period	-1880, 1991-1900, 1901-1920, 1921-1950, 1951-
XX4	Building's height	One - storey building, two storey building, multistorey building
XX5	Original ground floor use	Residential, Public, Comercial
XX6	Current ground floor use	Residential, Public, Comercial
XX7	Original upper floor use	Residential, Public, Comercial
XX8	Current upper floor use	Residential, Public, Comercial
XX9	Structural system's condition	Very good, Good, Average, Bad, Ruinded
X10	Facade's condition	Very good, Good, Average, Bad, Ruinded
X11	Roof's condition	Very good, Good, Average, Bad, Ruinded
X12	Architectural typology	Traditional Type, Ecletic influenced type, Vernacula type, Contemporary construction
X13	Additions (of any sort)	Existence, Non-existence
X14	Deteriorations	Non-reversible, Reversible, Non-existence
X15	Decoration - Morphological elements	Existence, Non-existence
X16	Qualitative assessment of building	Hightly remarkable, Remarkable, Interesting, Neutral, Dishamonious
X17	Legal protection	Existence, Non-existence

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recording. A card was completed for all the buildings of the region. Every main building that is located on each property was recorded at this unique card. For the out auxiliary buildings and the additions no separate card was completed; these are mentioned as part of observation and description of main building's changes. The card contains the building's code, its address, name (if any), owner and ownership status, brief description of its configuration and construction, height, condition of the structural system, façade and roof, potential additions, deteriorations of the façade's elements or morphology, map extract (scale 1:2000) where the contour and coverage of the building are pointed out, and finally, a representative picture of it. For the remarkable buildings, and for some less interesting, additional information was recorded at an extra card, with the aim to fully identify the built environment, such as more representative pictures of the building, observations of typological and/or morphological nature, decorative elements, plans, and relevant literature.

Picture 4:
Examples of maps.

The output of this project is a rating of buildings.

TEMPLATE

The template will be distributed in order to get more concrete information for methodology and guidelines.

What are topics (main interests) for the monitoring?

What type of data needs to be collected?

Which data are already available in the area of interest (geometrical survey, shapefiles, GIS database, etc.)?

Which data are planned to be monitored?

Who is responsible for data collecting?

What do you consider the greatest challenges in monitoring process?

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ANNEX

ACTIVITY 2.2 - LOGIC

DT 221

CHAPTER 1: WHY MONITORING
Brief introduction of the needs of monitoring come out from the previous analysis and meetings with LSG

CHAPTER 2: WHAT MONITORING
What is possible to monitor with the existing tools and procedures? Which problems do come out from the analysis related to this activity?

← DT 211

CHAPTER 3: WHO MONITORING
Who at the current situation is in charge to monitor HBAs transformations and other phaenomena

CHAPTER 4: HOW MONITORING
Which tools and instruments are already available to monitor HBA's phaenomena? Focus on DATABASE, INFO EXCHANGE, SENSORS, ICT TOOLS (EX.GIS AND BIM)

DT 222

OUR PROPOSALS
for an efficient and effective monitoring system.
The document could be structured on the following focus: a) monitoring transformations; b) monitoring risks; c) monitoring opportunities and should give answers to the lacks and problems emerging from DT221

← DT 211

DT 223

How to adapt DT222 solutions to the local needs and features

← DT 212