BUILDSPACE

Enabling Innovative Space-driven Services for Energy Efficient Buildings and Climate Resilient Cities

D4.2 BUILDSPACE Pilot's execution documentation – pre-pilot phase

June 2024

Document history

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List of acronyms

Acronym	Description
API	Application Programming Interface
AR	Augmented Reality
BGI	Blue-Green Infrastructure
CMIP6	Coupled Model Intercomparison Project Phase 6
CO	Completion
CWS	Citizen Weather Station
DEM	Digital Elevation Model
DSAI	Data Storage and Analysis Infrastructure
DSM	Digital Surface Model
DT	Digital Twin
DTM	Digital Terrain Model
EC	Economic
EF	Effectiveness
EG	Engagement
EGNSS	European Global Navigation Satellite System
EN	Environmental
FESTA	Flexible Transport Services for All
GA	Grant Agreement
GIS	Geographic Information System
KPI	Key Performance Indicator
LiDAR	Light Detection and Ranging
ML	Machine Learning

NPS	Net Promoter Score
NTUA	National Technical University of Athens
NUTS	Nomenclature of Territorial Units for Statistics
PV	Photovoltaic
QA/QC	Quality Assurance/Quality Control
RGB	Red Green Blue
RPR	Riga Planning Region
SC	Scientific
SE	Service
SLAM	Simultaneous Localization and Mapping
SMEs	Small and Medium Enterprises
SO	Social
TE	Technical
TR	Technology Release
UOC	University of Cambridge
UPM	Universidad Politécnica de Madrid
VR	Virtual Reality
PME	Preparation, Monitoring and Evaliation

Executive summary

Deliverable D4.2, "*BUILDSPACE Pilots' Execution Documentation – Pre-pilot Phase*," is the second in a series of documents within the context of Work Package WP4, "*Demonstration of BUILDSPACE towards Sustainable and Resilient Buildings and Cities*." This document is written as a continuation of D4.1, in which the foundations for monitoring and evaluation were prepared. In this second deliverable of WP4, the progress and advancements in the implementation of the services in each of the pilots are monitored, with a pre-pilot level of progress. Specifically, D4.2 focuses on documenting the readiness for deploying, testing, and evaluating the technological outcomes of BUILDSPACE during the pre-pilot phase, laying the groundwork for subsequent pilot stages.

The deliverable outlines the specific progress achieved in the pre-pilot phase of the project, where detailed activities were undertaken to ensure the pilots are operationally prepared. It provides updates on the test scenarios designed for each service-pilot pair, the setup of required infrastructure, data collection processes, and the technical readiness of the pilots. Furthermore, D4.2 offers a comprehensive evaluation of the services' preparation through Key Performance Indicators (KPIs), which are critical in assessing the services' effectiveness during upcoming testing phases.

The deliverable includes several key elements:

i. Pilot Readiness Status: A detailed account of the current status of pilot test scenarios, including infrastructure setup, data collection, and service preparation for each pilot site.
ii. Updated KPIs: This document updates the relevant KPIs to track the effectiveness and impact of BUILDSPACE services during the pre-pilot phase, ensuring they align with the project's overall objectives.
iii. Gantt Chart Progress: D4.2 provides updates on Gantt charts for tracking the timeline and milestones of each service, ensuring all tasks adhere to the defined schedules.
iv. Preparatory Activities: The deliverable outlines the technical and operational steps taken during the pre-pilot phase, including testing and integration processes to ensure the services are ready for field deployment.

In conclusion, D4.2 ensures that all preparatory activities are aligned with the goals of WP4. It establishes the foundation for the full pilot and large-scale implementation phases by documenting the detailed progress and ensuring that BUILDSPACE services are ready for real-world testing.

1 Introduction

1.1 About

BUILDSPACE is a Horizon Innovation Action that aims to couple terrestrial data from buildings with aerial imaging from drones equipped with thermal cameras and location annotated data to deliver innovative services for building and urban stakeholders and support decision making towards energy efficient buildings and climate resilient cities. In this context, the emerged BUILDSPACE solution will offer services at building scale, enabling the generation of multi-modal digital twins, and at city scale, providing decision support services for energy demand forecasting, urban heat analysis and urban flood analysis.

Work Package 4 (WP4), "Demonstration of BUILDSPACE towards sustainable and resilient buildings and cities," plays a crucial role in validating and assessing these services. WP4 is executed across four European countries, each with varying structural characteristics and climate conditions. The primary objective of WP4 is to establish a comprehensive framework for monitoring, evaluating, and preparing pilots. This includes setting up testbeds, running scenarios, and compiling overall evaluations of BUILDSPACE's impact and performance.

This deliverable (D4.2) is a central part of the WP4 activities. It presents the framework for pilot activities, coordinating tasks across the project's lifecycle under the well-established Preparation, Monitoring, and Evaluation PME Plan. The PME Plan is essential for ensuring the effective implementation, performance, and impact assessment of BUILDSPACE services across all pilot sites.

1.2 Purpose of this Document

The present document, titled "BUILDSPACE Pilots' Execution Documentation – Pre-pilot Phase", is the second deliverable in the WP4 series. It documents the activities conducted during the pre-pilot phase, from Tasks T4.2 to T4.5, providing detailed guidelines for the preparation and execution of BUILDSPACE pilot activities.

This deliverable aims to report the current status of services and their readiness for deployment in real-world environments. It describes all preparatory actions and the respective progress of the pilots, detailing infrastructure setup, test scenarios, data collection, and technical readiness. Additionally, it serves as a comprehensive framework for monitoring pilot progress and includes updated Key Performance Indicators (KPIs) to evaluate project outcomes. Through this, the document lays the groundwork for verifying the effectiveness and performance of the services before full deployment in the subsequent pilot phases.

The main objectives of D4.2 can be summarized as follows:

- Updating of the relevant KPIs for the evaluation of the project results and assessment of its progress.
- Update of the test scenarios to be carried out to assess the suitability of the services.

Update of the Gantt Charts to assess the progress of the services and their scheduling.

1.3 Connection to Other Documents

Deliverable D4.2, being the direct outcome of tasks T4.2, T4.3, T4.4 and T4.5, aims to report progress and results during the pre-pilot phase through the project pilots. Being also the core component of WP4, D4.2 is strongly linked to other work packages and deliverables, as it serves as a mechanism to assess project progress, impact and efficiency in achieving pre-defined objectives.

As such, it is aligned with:

- D2.1 - BUILDSPACE User Requirements
- D2.2 – Use Cases and Design of Applications Dashboards
- D3.1 – BUILDSPACE core platform and services
- D4.1 – BUILDSPACE Evaluation Methodology and Baseline Assessment

1.4 Document Structure

The present document is organized in 7 different sections, as described below:

- **Section 1 [Introduction]:** presents the objectives of WP4, the purpose of this document, and the connection to other WPs.
- **Section 2 [BUILDSPACE Services and Development. Description]:** provides an outline of the services to be developed within the BUILDSPACE system along with the pilots to be applied, as well as the development cycles of the project's life span. And also, provides the general Methodology which presents the foundations of the model to be adopted for the needs of Task T4.1 and delves into the core components of the Preparation, Monitoring, and Evaluation Framework to be applied in BUILDSPACE.
- **Section 3 [BUILDSPACE Monitoring and Testing Setup. Methodology]:** explains the monitoring framework adopted to track the whole activities – from preparation to testing - of the pilots' demonstration, as well as the methodology followed to define the workflow of the operation testing activities.
- **Section 4 [BUILDSPACE Monitoring – Building Scale Pilots]:** provides the monitoring of the deployment of those services related to the building scale in each pilot. This monitoring has been made following the context, objectives of each service – pilot pair, data and infrastructures as well as the pilots' engagement and implementation activities set in T4.1.
- **Section 5 [BUILDSPACE Monitoring – City Scale Pilots]:** provides the monitoring of the deployment of those services related to the city scale in each pilot. This monitoring has been made following the context, objectives of each service – pilot pair, data and infrastructures as well as the pilots' engagement and implementation activities set in T4.1.
- **Section 6 [Key Performance Indicators]:** provides the KPIs, both the services specific and the general, and moreover, explains the details of the evaluation scheme concerning the user.
- **Section 7 [Stakeholder Engagement and Social Acceptance]:**
- **Section 8 [Conclusions]:** the last section wraps up the content presented and highlights the next steps to be carried out in relationship to the present document.

2 BUILDSPACE Description and Methodologies

2.1 BUILDSPACE Services

BUILDSPACE project will introduce a suite of services, built upon a base platform, which will support decision making towards sustainable development both at building and city level. At building level, BUILDSPACE will develop two services:

- **SE1**: Digital Twin Generation
- **SE2**: Digital Twin Enrichment

while, at city level, it will provide the following ones:

- **SE3**: Built Environment Climate Scenarios
- **SE4**: Urban Heat Analysis and Resilience
- **SE5**: Urban Flood Analysis and Resilience

The overall BUILDSPACE framework will be designed, implemented, and validated in four real-world pilots across four countries, namely:

- Warsaw and Poznan, Poland [Pilot 1]
- Riga City, Latvia [Pilot 2]
- Municipality of Piraeus, Greece [Pilot 3]
- Ljubljana City, Slovenia [Pilot 4]

Not all services will be applied to all pilots, thus, for the BUILDSPACE demonstration needs, a matching scheme has been considered as described in the GA and presented in Table 1. The validation of building level and city level services will be performed in tasks T4.2 “BUILDSPACE Building Level Pilot Operation” and T4.3 “BUILDSPACE City Level Pilot Operation”, respectively.

Table 1: BUILDSPACE services’ application across pilots.

Service	Pilot
SE1	Pilot 1, Pilot 2, Pilot 3, Pilot 4
SE2	Pilot 1, Pilot 3
SE3	Pilot 2
SE4	Pilot 3
SE5	Pilot 4

2.1.0 Outline of the Activities of BUILDSPACE Services

In this section, we describe the core components of the services that are going to be deployed across pilots, as presented in Table 2.

Table 2. Description of BUILDSPACE services.

Service	Brief Description
SE1	SE1 constitutes a "horizontal" service of the BUILDSPACE project, in the sense it is going to be applied and evaluated across all pilots. This service will integrate methods for generating the geometry of buildings' digital twins from locally sourced geometry data and will build the associated interfaces for human-information interaction between users and digital twins. The resulting DTs will be linked to EGNSS data for integration into city-scale models and enable users to visualize the resulting DTs in mixed reality environments. This service will enable interactive screen- use, and VR/AR interfaces for visualizing DTs. The process is based on the buildings' DT automatic generation from registered points, visual, thermal, and EGNSS data, yielding to an object-oriented model comprised of building objects with tessellation-type as-is geometry and their spatial relationships. The service will be developed by UOC and will be tested on all pilots of the project for selected buildings.
SE2	SE2, constituting the successor of SE1, will enrich the obtained DTs for the pilots in Poland and Greece, by relying on thermography with drones and SLAM approaches. It will integrate thermal imaging with SLAM and photogrammetric approaches to allow semantic enrichment of 3D point clouds and enable cloud representations of the thermal performance of the building stock. The service will be developed by UPM and will be tested with drone and LiDAR systems for selected buildings in the Polish and Greek pilots.
SE3	This service calculates the energy demand of the building stock and its evolution according to different climate change scenarios. It relies on energy demand forecasting according to CMIP6 scenarios through the downscaling of climate data and its bias-correction with historical weather data. The service also includes two additional functionalities, one related to the calculation relevant KPIs to retrofitting strategy gains, and another to assess the solar PV potential, as well as the forecasted energy demand that could be covered by PV production (within the retrofitting strategies selection part). The service is led by CARTIF, with the collaboration of NTUA, and will be tested in the city of Riga, Latvia.
SE4	This service aims to examine the urban heat intensity and distribution at a detailed resolution level and incorporate socio-economic vulnerability factors to determine the urban heat risk under the present and future climate scenarios. The service will be developed by UPM, collaborating with MOBICS and CARTIF, with the support from NAZKA, ECMWF and SGL, and tested in the Municipality of Piraeus.
SE5	This service aims to calculate and the expected flood damage to the building stock and flood vulnerability hotspots with the impact of different structural blue-green infrastructure (BGI) and non-structural measures. It provides calculations and visualizations for the future according to

	different climate-driven scenarios in line with the standard accepted RCPs. The service also provides relevant condition guidance for the design and implementation of building retrofits and BGI measures through a decision support tool. The service will be developed by IMZI and NAZKA and will be tested in the city of Ljubljana, Slovenia.

2.2 BUILDSPACE Development Cycles

In terms of pilot activities, the present section describes the development cycles that will be followed at the BUILDSPACE project evolution. In BUILDSPACE's lifecycle, the workflow will be based on short iterative cycles of work. In this process, a parallel stream of activities will take place throughout the project for preparation, testing, validation, and exploitation of the intended results. This sequential integration will reflect the work being carried out during the project and will be split into three separate phases, as described in the Grant Agreement. In particular:

Pre-Pilot Phase [M14 - M17]: the pre-pilot phase marks the initial stage of the project's lifecycle, where the focus is on meticulous planning, groundwork, and preparation. During this phase, service providers and pilot partners lay the foundation for the subsequent activities by specializing in BUILDSPACE objectives and establishing the necessary infrastructure. Linking requirements with the pilot operation is also critical, ensuring that BUILDSPACE aligns with the expectations and needs of end-users. The pre-pilot phase serves as a testing ground for preliminary concepts, allowing to identify potential challenges and refine strategies before moving to the upcoming pilot phases.

Full Pilot Phase [M18 – M27]: the full pilot phase (first iteration) represents a crucial step in the project's lifecycle, where the planned services are tested on a smaller, yet comprehensive, scale. This phase involves the deployment of BUILDSPACE services in a controlled environment, closely resembling the intended operational testing on the pilots involved. The focus shifts to validating the project's functionality, usability, and the overall performance in real-world conditions. The successful completion of the full-pilot phase sets the stage for a more extensive large-scale operation.

Large Scale Pilot Phase [M18-M34]: the large-scale pilot phase (second iteration) is the culmination of iterative testing and refinement, where the project is deployed on a broader scale to a representative user base. This phase aims to simulate the operational environment at a scale that reflects the intended scope of BUILDSPACE. The feedback from the large-scale pilot phase informs final adjustments, and the project transitions into full operation following a successful evaluation, thus providing a robust and validated solution.

Figure 1. illustrates the BUILDSPACE pilot phases' evolution, while also depicting the launching of the related technical releases, since every pilot phase is closely related to a technical release. Pre-Pilot phase

starts after TR1 (M14 – M17), while the Full Pilot (M18 – M27) and the Large Scale (M18 – M34) pilot phases encapsulate the second and the final technical release, respectively.

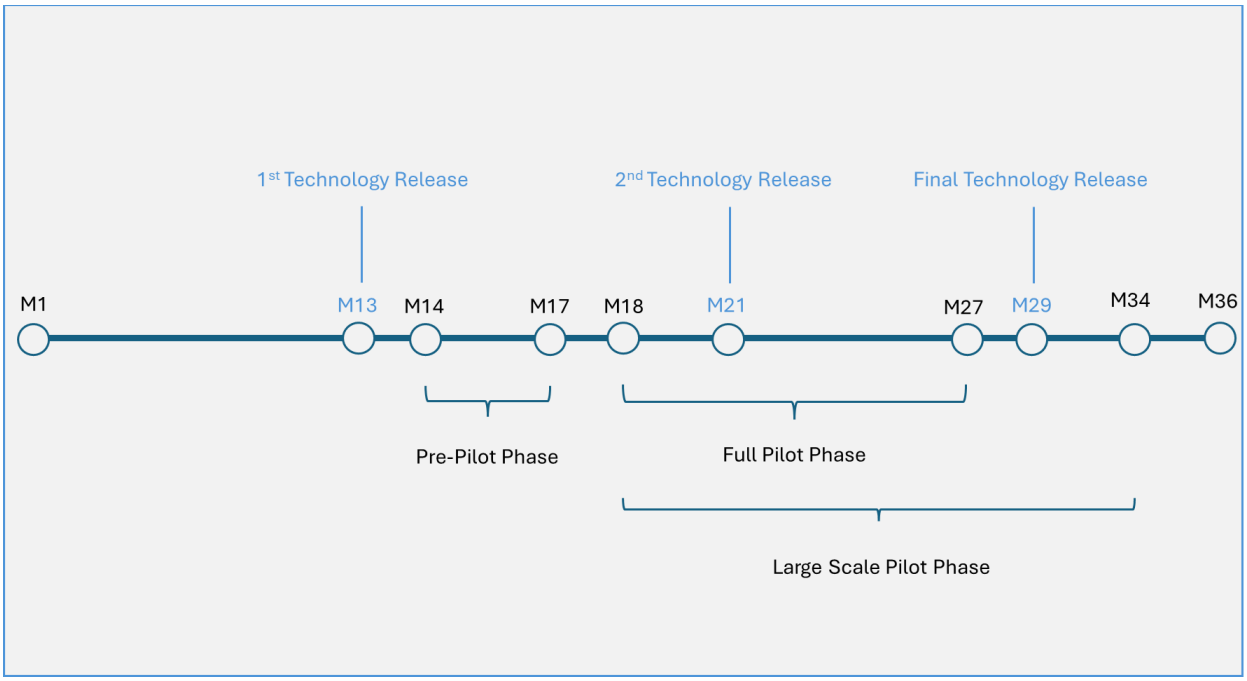

Figure 1. BUILDSPACE pilot phases in conjunction with technology releases' launching.

2.3 BUILDSPACE General Methodology

This section presents the foundations of BUILDSPACE general preparation, monitoring, and evaluation framework that will be used as the basement for the implementation activities of project's services across pilots (Arbour, 2020). It first provides the methodological background and the relevant model that will be adopted, continues with the description of the pilots' engagement and implementation activities, and ends with the final formulation of the proposed framework.

In the context of BUILDSPACE project, a V-type model is adopted for conducting the core steps of the engagement, operation, monitoring, and evaluation processes. The V-type (Verification & Validation) models have long served as robust frameworks for ensuring quality, reliability, and effectiveness of various systems and processes (Belcastro, 2013). Rooted in engineering principles, the V-models delineate a well-structured approach to systems' development and testing. The V-shaped scheme illustrates the parallel and interconnected nature of performing and validation activities, emphasizing also the importance of the early testing and continuous feedback loops throughout the whole project's lifecycle. This approach not only ensures that the system meets the specified requirements, but also enhances the overall efficiency and success of the project.

2.3.0 Preparation, Monitoring, and Evaluation Model

The whole BUILDSPACE development includes three technology releases (TR1, Interim TR, and Final TR), which will be span in three operation phases, namely, the pre-pilot phase, the full pilot operation phase and the large-scale pilot operation one. Based on this fact, we may consider the classical V-shaped model and extend it to a double-V shaped model, to adequately address the needs of BUILDSPACE project, considering its triple operation nature. A graphical illustration of the adopted methodology is presented in Figure 2.

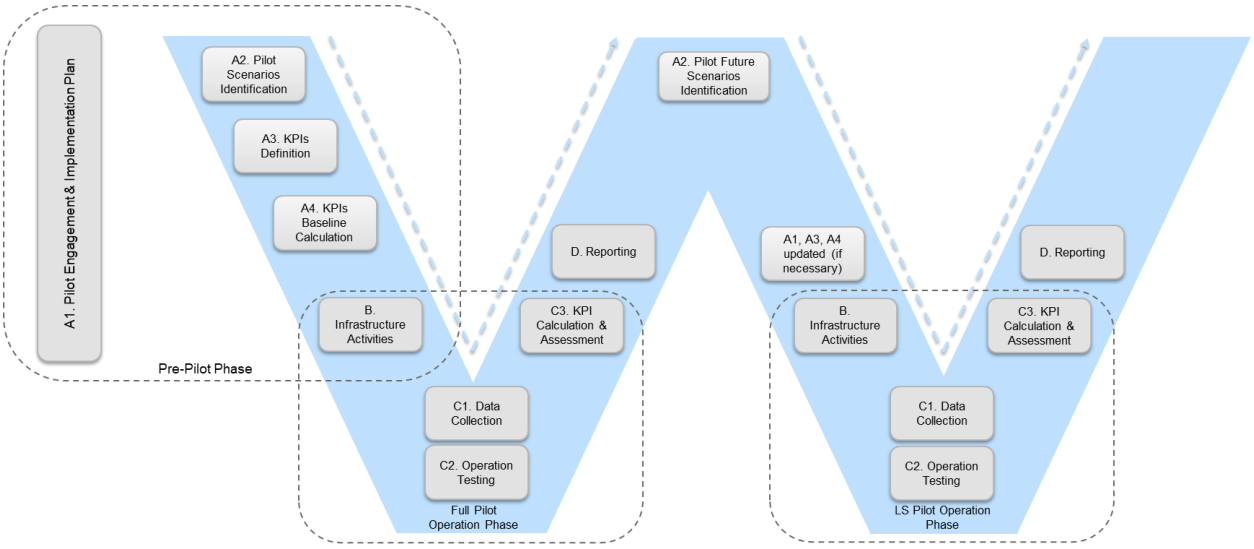

Figure 2. The BUILDSPACE double V shaped adopted PME model.

To monitor more effectively the whole demonstration processes of the services across pilots, the whole set of Task T4.1 related activities are split into four main groups. We consider: A. Preparation activities, B. Infrastructure activities, C. Data Collection, Measurement, and Evaluation activities, and D. Reporting activities, which are described more explicitly below.

A. Preparation Activities

Preparation refers to the first stream of activities initiating at the early beginning of the project and are expected to be present throughout the whole duration of the pilots' cycle. These activities refer mainly to actions related to the preparation of pilots' implementation and consist of the following sub-activities:

- *A1. Engagement and Implementation Plan Design/Update:* the formulation of the engagement and implementation plan is based on a Gantt chart serving as a scheduling and monitoring tool for the pilots' implementation. The plan is developed at the beginning of WP4 and provides an estimation on the pilot activities' duration.
- *A2. Scenarios Identification:* it refers to the pilot scenarios that are going to be tested. In the initial period (M14 – M17), scenarios are focusing on the testbed setup of the pilots. Later, in the full

(M18 – M27) and large-scale (M18 – M34) pilot operation phases, scenarios are going to be updated to be aligned with the Use Cases defined in deliverable D2.2.

- *A3. KPIs Definition/Update:* KPIs reflect the key features of BUILDSPACE services, are defined at the beginning of WP4, and are the basic scoring scheme for the whole evaluation process. KPIs are allowed to be refined and/or updated throughout the pilots' cycle, following the needs and the progress of implementation, and should be aligned with the maturity level of the three technology releases.
- *A4. KPIs Target/Base Values Calculation.* Baseline and/or Target values' calculation refers to the definition of reference data that will be used for comparison with the actual KPIs values at the end of operation phases.

B. Infrastructure Activities

Infrastructure-related activities refer to all actions that are necessary for the supply, deployment, and integration of equipment and tools for the pilots' operation. To better capture the needs of pilots' operation, while also taking into account the special features of building and city level pilot real-world cases, infrastructure activities have been further split into two sub-groups, as follows:

- *B1. Technology/Equipment/Building/Area:* a list of activities covering pilots' needs and requirements via the installation of appropriate equipment, as well as the building and area selection, for the services' groups SE1, SE2 and SE3, SE4, SE5, respectively.
- *B2.* Tool/Platform/Service Deployment/Integration: a list of activities foreseen to cover the development and deployment of the tools, platforms and sub-services that are going to be used by each pilot.

C. Data Collection, Monitoring and Evaluation Activities

Data collection, monitoring and evaluation activities refer to all actions that cover the core implementation of pilots' operation phase and are further split into three sub-groups:

- *C1. Data Collection:* Data sets required for the smooth implementation of services' testing across pilots.
- *C2. Operation Testing.* Activities related to the testing of equipment/tools and services. Such activities may be present during the whole pilot's cycle to reflect not only the needs of the two operation phases, the Full Demo and the Large Scale, but also the pre-pilot one.
  C3. KPIs Calculation and Assessment. Activities related to the calculation of KPIs after the implementation, to assess the fulfilment of the initial goals and the pilot's success in providing the expected results.

D. Reporting Activities

Reporting activities refer to the development of each scale – building and city - deliverables and reports. Their duration may vary between different pilots.

Finally, considering that both services' development and pilot demonstration activities cover two different scales, building and city, the double V-shaped model has been further expanded to the Double-Double V (D^2V) model to cover these two perspectives, as illustrated in Figure 3.

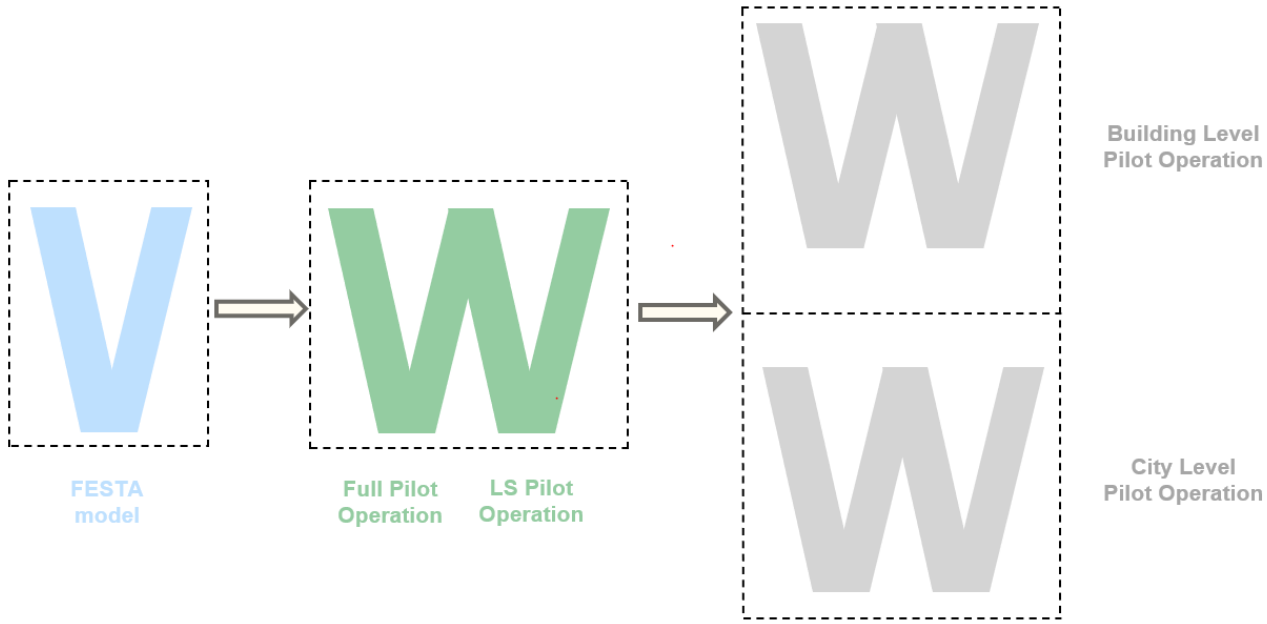

Figure 3. The BUILDSPACE D^2 V model

2.4 BUILDSPACE Key Performance Indicators

Key Performance Indicators (KPIs) play a pivotal role in the successful evaluation of the project's outcomes, providing a multi-perspective structured framework for assessing and gauging the effectiveness and other dimensions of the implemented services (Reed et al., 2021). The definition of adequate KPIs involves a thoughtful and strategic approach that begins with a clear understanding of the project's goals and objectives. KPIs are quantifiable variables that reflect critical aspects of the project's performance and are chosen based on their direct relevance to the desired outcomes. Careful consideration is given to ensure that the chosen KPIs are both meaningful and actionable, providing valuable information for decision making.

BUILDSPACE will validate its tools and services with a methodology which covers, as much as possible, all the aspects of the project and its expected outcomes. The services to be developed are going to be evaluated through a set of KPIs, both at the general level (across all services) and by adopting services - specific indicators. The general KPIs are common for the whole BUILDSPACE solution, while the services - specific KPIs correspond to the services' specific features. In addition, user satisfaction will be tracked through dedicated KPIs.

Services' oriented KPIs were derived through an iterative process, based on dedicated online meetings with all involved partners of BUILDSPACE WP4. To this end, a dedicated template was used.

To comprehensively assess the diverse "facets" of BUILDSPACE project, the relevant KPIs have been categorized into three groups, as described below:
- *Economic KPIs:* These indicators focus on assessing the financial aspects of a service. They measure the efficiency and effectiveness of resource utilization, cost management, and overall economic impact.
- *Technical KPIs:* These indicators pertain to the functionality and performance of the technical aspects of the services. They gauge the effectiveness of services, ensuring that they meet specified standards and contribute to the overall success of the project.
- *Scientific KPIs:* These indicators assess the quality and impact of scientific contributions and advancements, providing a framework for evaluating the project's scientific rigor and contribution to knowledge.
- *Social KPIs:* These indicators focus on the impact a service may have on the community and stakeholders. They measure aspects such as user satisfaction and community engagement, providing insights into the project's ability to meet the needs of beneficiaries.
- *Environmental KPIs:* These indicators evaluate the ecological impact of a service. They measure emissions and other environmental factors, contributing to the adoption of eco-friendly and sustainability practices.

Beyond the above classification, the key performance indicators have been also classified at one more layer, as follows:
- *Completion KPIs:* they measure the progress and successful conclusion of specific project tasks, activities, and milestones.
- *Effectiveness KPIs:* they assess the extent to which the project is achieving its stated objectives and delivering the intended outcomes.
- *Engagement KPIs:* they focus on the level of possible interaction of end-users with the broader community.

The above two-layer KPIs taxonomy is depicted in Figure 4.

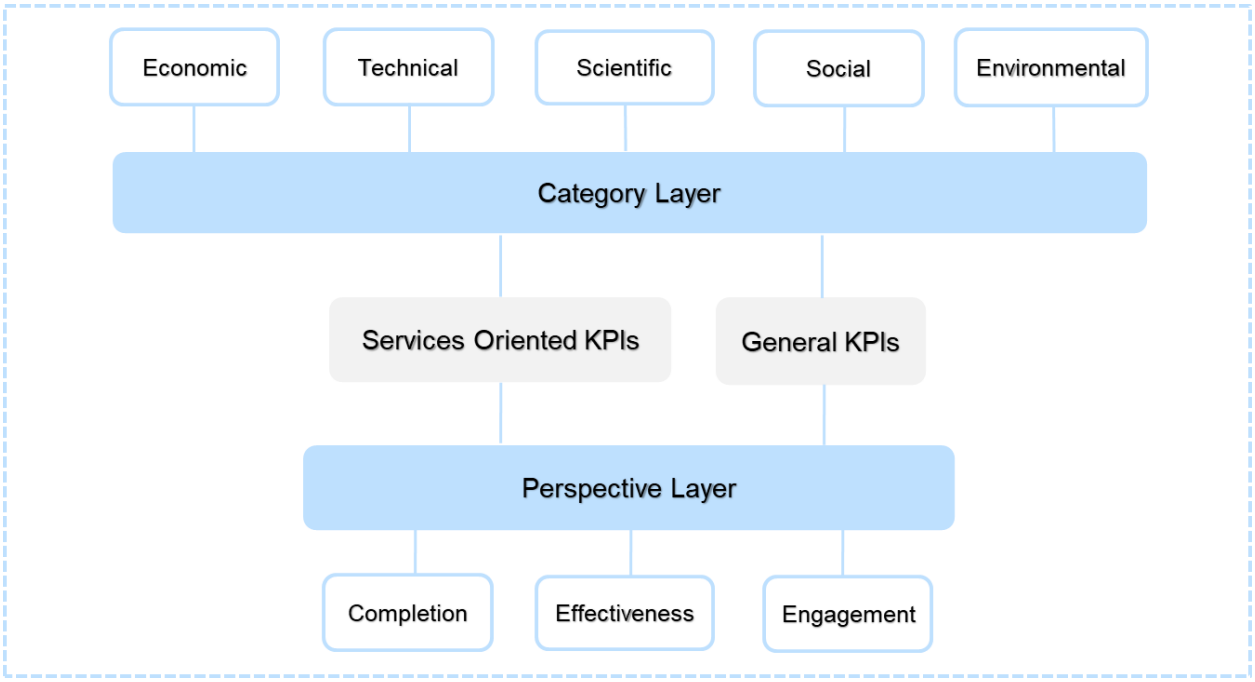

Figure 4. Taxonomy of BUILDSPACE KPIs

User Perspective

The User Satisfaction Plan of BUILDSPACE aims to measure the usability and acceptance of its outcomes, by evaluating the generated suite of services from its intended users. These users are deriving from the pilot demonstrators and the target groups identified in the user stories description (see Deliverables D2.1 "BUILDSPACE User Requirements" and D2.2 "Use Cases and Design of Applications' Dashboards").

In this context, for the needs of BUILDSPACE, three "aggregated" KPIs will be used to capture the user point of view, in particular KPI 16, KPI 17, and KPI 20. These three indicators entail, separately, a systematic approach in order to track quantitatively how satisfied are the related users by the emerged solutions. The three separate methodologies are described below.

4.3.A. Calculation of KPI 16 [Usability Perspective]

To measure usability, the following questions, along with the corresponding performance scales, are going to used:

1. Overall, how would you rate the ease of use of Service X?
   i. Very difficult (1)
   ii. Difficult (2)
   iii. Neutral (3)
   iv. Easy (4)

v. Very easy (5)

2. How intuitive is the navigation on Service X?
   i. Not intuitive at all (1)
   ii. Somewhat intuitive (2)
   iii. Neutral (3)
   iv. Intuitive (4)
   v. Extremely intuitive (4)
3. To what extent did you encounter difficulties while performing tasks on Service X?
   i. Experienced a lot of difficulties (1)
   ii. Experienced some difficulties (2)
   iii. Neither easy nor difficult (3)
   iv. Experienced few difficulties (4)
   v. Experienced no difficulties (5)
4. How quickly were you able to complete tasks on Service X?
   i. Very slowly (1)
   ii. Slowly (2)
   iii. At a moderate pace (3)
   iv. Quickly (4)
   v. Very quickly (5)
5. Were the features and functionalities of Service X easily understandable?
   i. Not understandable at all (1)
   ii. Somewhat understandable (2)
   iii. Neutral (3)
   iv. Understandable (4)
   v. Very understandable (5)

The final score of usability is, then, calculated as follows:

$$\text{Mean Score} = \sum \frac{\text{Individual Scores}}{\text{Number of Responses}}$$

$$\text{Final Score} = \frac{\text{Mean Score}}{5}$$

Of course, depending on the needs of BUILDSPACE at the later operation phases, the questions, the responses, the scale, and the calculation formulae are allowed to be modified appropriately.

4.3.B Calculation of KPI 17 [Social Acceptance Perspective]

The calculation of this KPI will be based on the following Net Promoter Score (NPS) question:

- On scale of 0 to 10, how likely are you to recommend the developed service X to others?

Then, we consider three categories of respondents:

1. **Promoters [8-10]:** These users are highly satisfied and are likely to recommend BUILDSPACE services to others.
2. **Passives [5-7]:** These users are satisfied, but not as enthusiastic as promoters. They are unlikely to actively promote BUILDSPACE services, but also unlikely to actively discourage others.
3. **Detractors [0-4]:** These users are dissatisfied and may have issues with the BUILDSPACE services. They are unlikely to recommend the services and may share negative impact.

The NPS is, then, calculated through the following formula:

$$\text{NPS} = \%\ \text{Promoters} - \%\ \text{Detractors}$$

The values of NPS can range within the interval [-100, 100] and are interpreted as follows:

1. [0, 30]: The service is generally considered good.
2. [31, 60]: The service is considered as excellent.
3. [61, 100]: The service is considered as outstanding.

4.3.C. Calculation of KPI 20 [Value Recognition Perspective]

To measure this KPI, a similar approach to the previous ones will be followed. In particular, questions of the form will be used:

- How would you rate the business value derived from the BUILDSPACE solutions on a scale of 1 to 5, where 1 indicates low recognition and 5 indicates high recognition?"
    i. Low Recognition (1)
    ii. Limited Recognition (2)
    iii. Moderate Recognition (3)
    iv. High Recognition (4)
    v. Very High Recognition (5)

To achieve the pre-defined targets, we consider only the respondents that have responded at least “3”.

2.5 BUILDSPACE Testing Setup, Monitoring, and Operation

In this section, we describe more in detail the testing setup, monitoring, and operation activities of the PME plan. BUILDSPACE’s setup and operation activities describe how the developed tools and services will be deployed and tested in the pilot demonstrators. Since BUILDSPACE involves pilots and services with different features, it is necessary to adequately track and monitor the project activities. Therefore, an integrated engagement methodological framework regarding the testbed setup, the operation, and the

monitoring activities is proposed in this section, that can efficiently be applied to all services – pilots' pairs of the project. The BUILDSPACE's testing setup, monitoring, and operation layer of the evaluation framework aims to establish:

- **A Feedback Mechanism**, i.e. the establishment of effective communication channels for collecting feedback on implemented services and technologies.
- **A Validation Mechanism**, i.e. the performance validation of services in real-world scenarios.

Following T4.1 working methodology, pilots related to the building scale has been set as coordinator of the task for of the building scale services deployment (T4.2) and a pilot related to the city scale service deployment has been set as responsible for T4.2 in which city scale services are being deployed. Regular meetings for these two scales have been set in order to follow up the adequate progress on the pilots implementation.

The above communication and the further engagement of pilot partners led to an agreement regarding the monitoring and the operation testing schemes, formulated as described in the next sections.

2.5.0 Monitoring

The adoption of Gantt charts for monitoring the activities of services' deployment across pilots confers several distinct advantages. Gantt charts provide a visually intuitive representation of the project's timeline, allowing the relevant partners to grasp the sequential execution of activities across different pilot phases effortlessly. This visual clarity facilitates the pilot engagement planning, enabling relevant partners to align service deployment with pre-defined schedules. Task dependencies and critical paths become readily apparent, promoting effective coordination and minimizing potential bottlenecks. Additionally, Gantt chart formulation offers a real-time overview of the progress made in each pilot phase, allowing for timely interventions and corrective actions if deviations from the planned schedule occur.

In this context, since the above formulation serves as an indispensable tool for enhancing BUILDSPACE success, all pilot demonstration activities are described in distinct Gantt charts for each different service. To this, an appropriate template was adopted.

2.5.1 Set up and Operation Testing

In this section, we describe the steps for designing the operation testing of the deployed services across pilots. To this, the concept of test scenario will be fully adopted across the whole PME Plan.

A test scenario is a detailed and scripted description of a specific situation under which a BUILDSPACE service will be tested. It outlines the steps, inputs, expected outcomes, and conditions that are necessary to assess functionality, performance, and effectiveness of the services in a pilot-controlled environment.

Beyond performance measurement, test scenarios are designed to simulate real-world usage and are essential components of the measurement and evaluation process for several reasons such as the following ones:

1. *Realistic simulation:* test scenarios aim to replicate real-world conditions, ensuring that the evaluation process closely mirrors the actual use of the service in operational settings.

2. *Identifying system behavior:* this includes assessing how the service responds to specific inputs and adapts to different conditions.

3. *Verification of requirements:* test scenarios are aligned with pre-defined requirements and specifications of the services.

4. *Error detection and correction:* by systematically testing various functionalities, various crucial issues can be identified early in the process, allowing for timely corrections and refinements in order to enhance the overall quality of the service.

5. *Iterative improvement:* feedback from each round of testing informs adjustments and refinements to the service, contributing to the continuous improvement and optimization.

In this context, BUILDSPACE services will be tested in various scenarios. To better track the objectives, the scope, and the workflow of each scenario, an appropriate template was used (Table 4). Beyond the specific features of each service - pilot pair, the connection with specific use cases is also tracked. The BUILDSPACE use cases have already been defined in WP2 and explicitly tracked in the Deliverable D2.2 “Use Cases and Design of Applications’ Dashboards”.

Table 3. Template for the definition of test scenarios.

Scenario ID	*Define a specific ID for the test scenario that is going to be conducted.*
Developer(s)	*Indicate the partner(s) contributing to the service under consideration in the present test scenario.*
Pilot	*Indicate the relevant pilot where the test scenario will be applied.*

Related Use Case(s)	*Indicate the Use Case(s) that are reflected in the test scenario under consideration.*
Objective(s)	*Indicate the specific objective(s) of the test scenario. Describe why the test scenario meets the requirements of the service objectives.*
Location	*Indicate the location of the area/building of the scenario under consideration. Please also provide its delineation (if it is available).*
Scale scope	*Indicate the scale scope of the targeted implementation (building, neighborhood, city, etc.). You may also consider factors such as area, volume, number of buildings, etc.*
Data	*Include the required data to adequately implement the scenario.*
Resources	*Indicate the required resources which need to be used in order to implement the scenario.*
Workflow	*Define the order of activities for the implementation of the test scenario.*
Additional considerations	*Please include additional issues that need to be considered in the implementation of the test scenario.*

3 BUILDSPACE Monitoring. Building Level Pilots Operation (T4.2)

This section will test and evaluate the services at building level in selected pilot buildings. The pilot will assess DT generation service during the construction of new buildings, while the DT enrichment service will be evaluated in a new building (in the Polish pilot) to check the quality of the construction and in existing buildings in Greece to perform inspection for potential renovation. Also, the application of these services will be assessed in the two remaining pilots in Greece and Poland, in selected buildings. This task will also organize two live events, where external users will be invited to a real demonstration of the services at selected pilot sites.

T4.2 coordination activities

Within Task 4.2, MOS coordinated building-level Pilots' activities during the pre-pilot phase. As part of these coordination efforts, MOS organized four meetings with building-level Pilots aimed at coordinating and supporting the Pilots' activities. During the first meeting, building-level Pilots introduced their Pilot sites and solutions that are being developed for them with Services 1 and 2. They also provided updates on their preparatory activities, focusing on subsequent steps of the Gantt Charts, the timeline, and any expected deviations. The second meeting centered around updates in pre-pilot phase activities of all partners. They informed about meetings with technical Partners regarding guidelines for drone flights, processing of the data obtained during drone flyovers, and organizational aspects. All partners gave updates concerning planned or ongoing drone flyovers and laser scanning deviations and arrangements. The focus of the third meeting was placed on the Pilots' input to this deliverable 4.2. UPM presented the structure of the report and the section where the building-level Pilots' contribution is expected. The fourth meeting concerned Pilots' first contribution to the report, focusing on the content already inserted into the document, what is pending, and additionally expected.

3.1 Service 1

3.1.0 Pilot 1

3.1.0.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who the service provider will be, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 1.1

Table 4. Operation testing for the (SE1, Pilot 1) case (Test Scenario S1.1).

Scenario ID	S1.1
Developer	UOC

Pilot	Warsaw, Poland [MOS]
Related Use Case	UC1.1
Objective	The objective of this scenario is the generation of the Digital Twin of a building from locally sourced geometry data, as well as formation of the functionality to enable human-information interaction between users and Digital Twin in mixed reality. BIM models, indispensable for the development of the corresponding service, are available for this building.
Location	Warsaw, Banacha 2B street, Faculty of Psychology of the University of Warsaw, Coordinates: (1): 52.21282034 N, 20.9859821 E; (2): 52.20307146 N, 20.96895569 E; (3): 52.20387586 N, 20.97299458 E; (4): 52.2272656 N, 20.99728432 E.
Scale Scope	Building (Figure 5) Total net area: almost 21000 m^2, Plot area: around 7500 m^2.
Data	Point cloud data (both internal and external), BIM models (IFC), EGNSS data.
Resources	VR goggles, Trimble Real Works, Autodesk Recap, Unity Reflect, Twin View, 3Ddeling, TrueScan, ContextCapture, Laser Scanning.
Workflow	1. Drone flyover – photogrammetric, 2. Flight data processing to obtain point cloud-UPM and handover to UoC, 3. Generation of the Digital Twin from point cloud data and connecting it to the BIM model (IFC), 4. Connection of Digital Twin with EGNSS data, 5. Development of the functionality enabling visualization of the Digital Twin with all the data mentioned in mixed reality environments (VR glasses, tablets/smartphones).
Additional Considerations	The technical specifications for the data collection within SE1 operation testing are presented in D4.1 (Appendix III and Appendix IV).

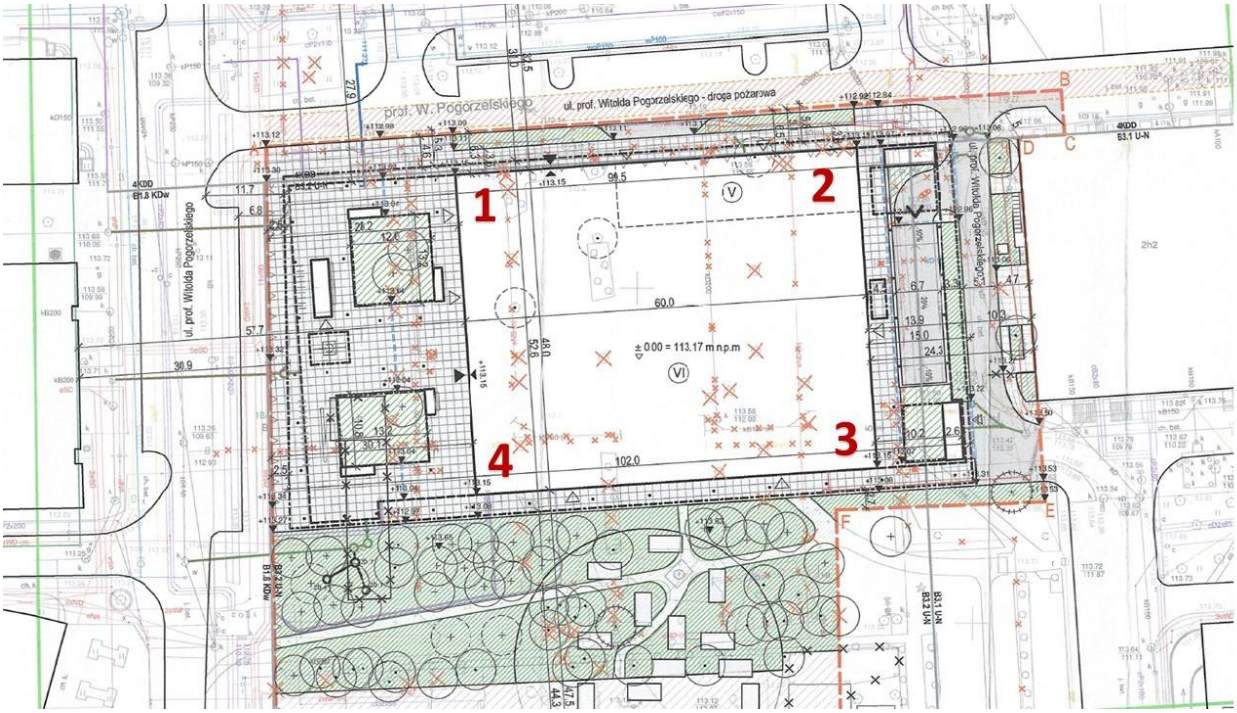

Figure 5. Building delineation for the conduction of scenario S1.1.

Scenario 1.2

Table 5. Operation testing for the (SE1, Pilot 1) case (Test Scenario S1.2).

Scenario ID	S1.2
Developer	UOC
Pilot	Poznan, Poland [MOS]
Related Use Case	UC1.1
Objective	The aim of this scenario is to enable the display of various construction phases of building in the Digital Twin (such as completed, ongoing, and delayed elements). Additionally, an algorithm comparing point cloud information with 4D BIM model will enable visualization of upcoming stages of construction works as well as delayed objects in the Digital Twin. Data mentioned will be additionally connected with AR devices and interaction between user and Digital Twin will be enabled. The building chosen for the testbed scenario is at an early stage of construction process and will continue being built for approx. next 3 years. This fact will enable tests of visualization of various construction phases.
Location	Poznan, Glogowska 151 street,

	Rectorate of Poznan University of Technology, Coordinates: (1): 52.40586243 N, 16.95077849 E.
Scale Scope	Building (Figure 6), Usage area: almost 6000 m^2, Plot area: around 8100 m^2,
Data	Digital Twin (point cloud data), 4D BIM model (IFC format).
Resources	VR/AR goggles, Trimble Real Works, Autodesk Recap, Unity Reflect, Twin View, 3Ddeling, TrueScan, ContextCapture, Bexel.
Workflow	1. Preparation of the as-designed BIM model (of the structural elements) and 4D BIM model (as designed BIM model with time information attached), 2. Drone flyover – photogrammetric, 3. Flight data processing to obtain point cloud, 4. Algorithm development and testing on the comparison of 4D as-designed BIM model and the registered point cloud model, 5. Verification on the algorithm to generate the outcome of the comparison of point cloud model and as-designed BIM model, 6. Visualization of the Digital Twin model and BIM model in VR/ AR interface.
Additional Considerations	The technical specifications for the data collection within SE1 operation testing are presented in D4.1 (Appendix III and Appendix IV.)

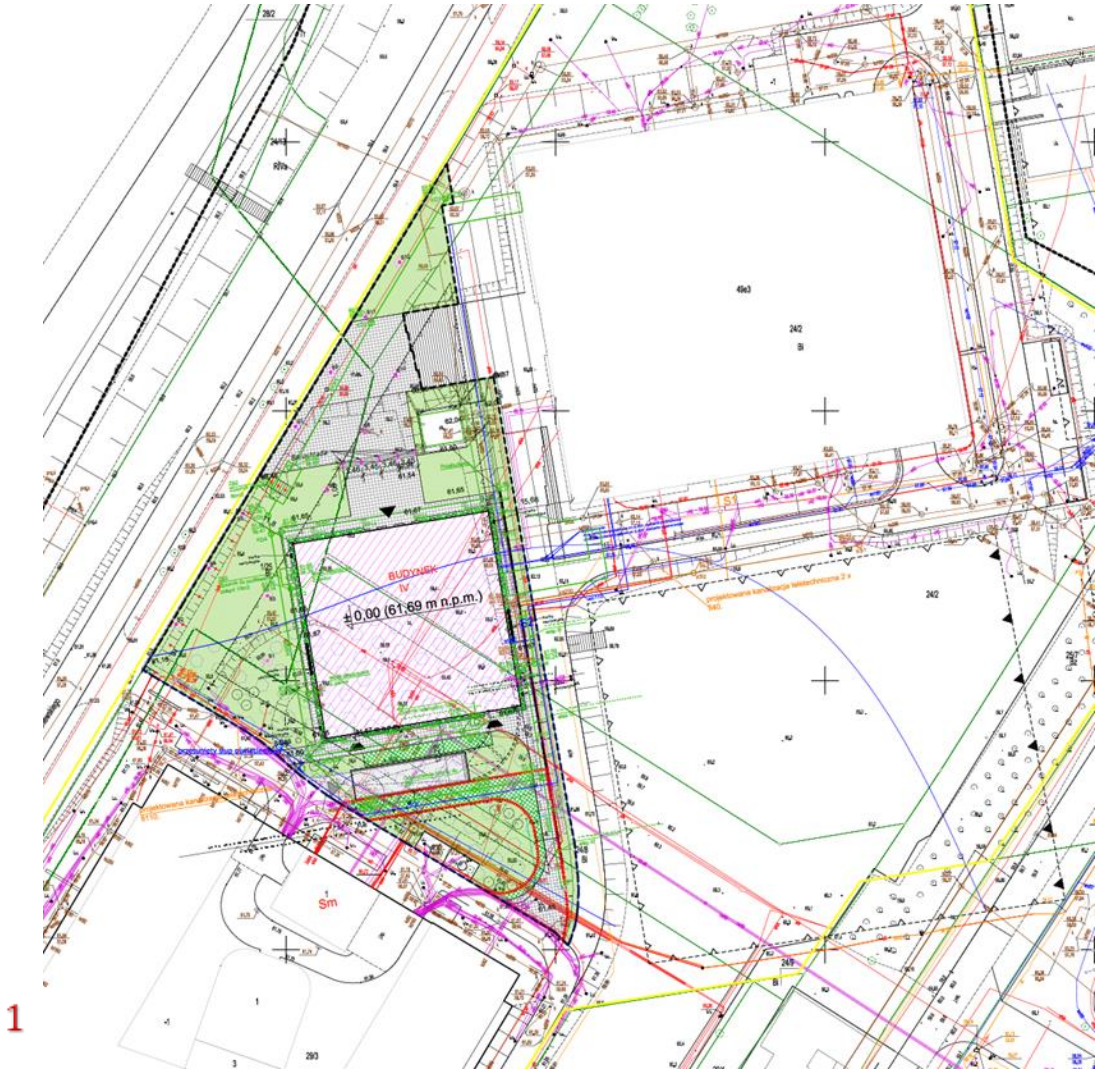

Figure 6. Building delineation for the conduction of test scenario S1.2.

Scenario 1.3

Table 6. Operation testing for the (SE1, Pilot 1) case (test scenario S1.3).

Scenario ID	S1.3
Developer	UOC
Pilot	Warsaw, Poland [MOS]
Related Use Case	UC1.1

Objective	The objective of this scenario is to enable defining relationships between objects and using this information to infer hidden objects (for example pipe segment inside wall). It will deliver algorithms defining the building's elements lifecycle, generating maintenance schedules, informing which elements are in need of service or replacement. The building chosen for this testbed scenario will have its Digital Twin developed in Test Scenario S1.1.
Location	Similar to S1.1
Scale Scope	Similar to S1.1
Data	Digital Twin (consisting of data from at least 2 internal scans)
Resources	Trimble Real Works, Autodesk Recap, Unity Reflect, Twin View, 3Ddeling, TrueScan, Laser scanning, 3D cameras
Workflow	1. Drone flyover – photogrammetric, 2. Flight data processing to obtain point cloud-UPM and handover to UOC, 3. Digital Twin reconstruction based on the collected point cloud model with the location information of MEP terminal devices, equipment and its service scope, 4. Analysis of the relevant spatial relationship of the MEP terminal devices and the equipment in the Digital Twin context, 5. Creation of the hidden objects in the Digital Twin, based on the results from the steps 3 and 4, and visualize it in the VR/AR interface.
Additional Considerations	The technical specifications for the data collection within SE1 operation testing are presented in D4.1 (Appendix III and Appendix IV).

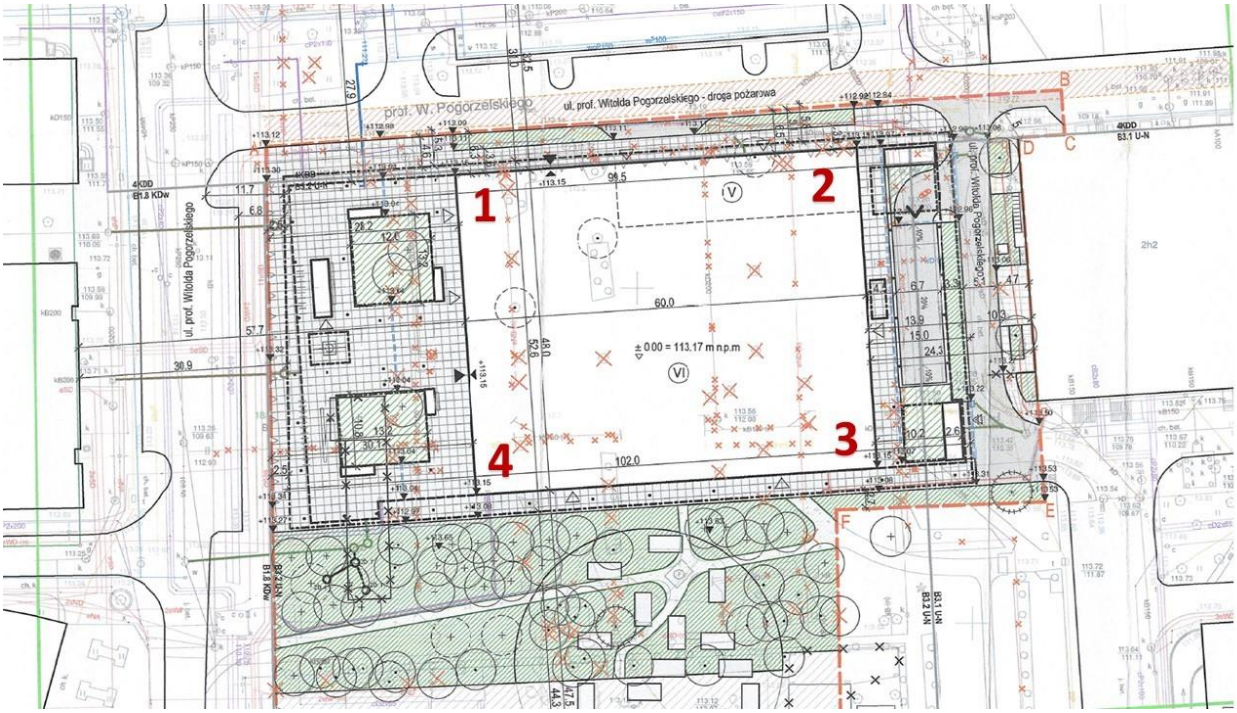

Figure 7. Building delineation for the conduction of scenario S1.1.

3.1.0.2 Pre-Pilot Phase. Progress

During the Pre-Pilot Phase, MOS conducted a photogrammetric drone flyover on Warsaw Pilot, delivering the data for processing to obtain a point cloud. Over 4 thousand images were provided to ensure data accuracy. The XYZ coordinates of photo points were localized in accordance with System 2000 zone 7 (EPSG 2178). Laser scanning activities have started along with the Gantt Chart and are still ongoing. SLAM data will likely be delivered to UPM on M17. According to the Gantt Chart, photogrammetry data collection on the Poznan Pilot will start on M18.

Table 7. (SE1, Pilot 1) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress pre-pìlot phase	Data collected
	B. Infrastructure-related Activities			
	B1. Technology/Equipment/Building			
MOS, UOC, UPM	B1.1. Building selection	M10-M11	Completed	Faculty of Psychology of the University of Warsaw; Rectorate of Poznan University of Technology

MOS, SLG UOC	B1.2. Drone/SLAM equipment rent.	M12-M15	Completed	
	B2. Tool/Platform/Service Deployment/integration			
UOC	B2.1. EGNSS integration into building-scale model	M18 - M20	In progress	
UOC	B2.2. Provision of AR and VR interface	M29	In progress	
UOC	B2.3. Digital Twin and Point cloud integration into AR and VR interface	M29	In progress	
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
MOS	C1.1. Definition of data collection procedure	M6 – M14	Completed	specifications
MOS	C1.2. XYZ coordinates	M14	Completed	photo points localized in accordance with System 2000 zone 7 (EPSG 2178)
MOS	C1.3. Thermal information	M14	Completed	3535 images
MOS	C1.4. RGB information	M14	Completed	4184 photogrammetric images in .NAV format file
MOS, MOBICS	C1.5. EGNSS location	M13-M17	Completed	Information delivered as coordinates of photo points localised in accordance with System 2000 zone 7 (EPSG 2178)
	C2. Operation Testing			
	C2.1. Testbed scenario S1.1			
MOS	C2.1.1. Drone flyover - photogrammetric	M14	Completed	4184 photogrammetric images in .NAV format file
MOS, UPM	C2.1.2. Flight data processing to obtain point cloud	M13-M16	Completed	
MOS, UOC	C2.1.3. DT Generation from point cloud data and connection to BIM model	M16-M18	New Scheduling	waiting for the point cloud data (the schedule will be reconfirmed according to the

				new data collection plan)
UOC, MOBICS	C2.1.4. DT connection with EGNSS data	M18-M20	In progress	
UOC	C2.1.5. Development of the functionality enabling visualization of the DT with all the data mentioned in MR	M29	In progress	
	C2.2. Testbed scenario S1.2			
MOS, UOC	C2.2.1. Preparation of as-designed BIM model and 4D BIM model	M13-M14	Completed	
MOS, UOC	C2.2.2. Drone flyover - photogrammetric	M15-M22	In progress	
UOC	C2.2.3. Flight data processing to obtain point cloud	M18-M22	In progress	
UOC	C2.2.4. Algorithm development/testing on the comparison of 4D as-designed BIM model and the registered point cloud model	M19-M20	In progress	
UOC	C2.2.5. Verification on the algorithm to generate the outcome of the comparison of point cloud model and as-designed BIM model	M22-M25	In progress	
UOC	C2.2.6. Visualization of the Digital Twin model and BIM model in VR/AR interface	M29	In progress	
	C2.3. Testbed scenario S1.3			
MOS, UOC	C2.3.1. Drone flyover - photogrammetric	M14	Completed	4184 photogrammetric images in .NAV format file
MOS, UPM	C2.3.2. Flight data processing to obtain point cloud	M13-M16	Completed	
UOC	C2.3.3. DT reconstruction based on the collected point cloud model with the location information of MEP terminal devices, equipment and its service scope	M16-M20	In progress	
UOC	C2.3.4. Analysis of the relevant spatial relationship of the MEP terminal devices and the equipment in the Digital Twin context	M20-M25	In progress	
UOC	C2.3.5. Creation of the hidden objects in the DT and visualization in the VR/AR interface	M29	In progress	
UOC	C2.4. Testing results of building element detection	M14-M17	New Scheduling	waiting for the point cloud data (the schedule will

				be reconfirmed according to the new data collection plan)
UOC	C2.5. Testing results of building element detection and object relationships	M15-M21	In progress	
UOC	C2.6. Visualization testing	M22-M29	In progress	

Table 8. (SE1, Pilot 1) Gantt Chart progress. Pre-Pilot phase

Service: SE1 | Pilot Partner: MOS Leader: UOC | Other Partners Involved: MOBICS, SLG		2023													2024															2025												
		Pre-Pilot Phase													Full-Pilot Operation Phase															Large-Scale Operation Phase												
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
Streams of Activities **WP4 & Project-level Pilot-related Milestones**	**Responsible Partner**													1st TR				MS 5				2nd TR						MS 7		Final TR					MS 10		
A. Preparation Activities																																					
A1. Pilot Engagement & Implementation Plan Design/Update	UOC, MOS																																				
A2. Pilot Scenarios Identification	UOC, MOS																																				
A3. KPIs Definition/Update (if needed)	MOS, UOC																																				
A4. KPIs Target/Base Values Calculation	MOS, UOC																																				
B. Infrastructure-related Activities																																					
B.1 Technology/Equipment/Building	MOS, UOC, UPM																																				
B1.1. Building selection	MOS, UOC, UPM																																				
B1.2. Drone/SLAM equipment rent	MOS, SLG																																				
B2. Tool/Platform/Service Deployment/integration	UOC																																				
B2.1. EGNSS integration into building-scale model	UOC																																				
B2.2. Provision of AR and VR interface	UOC																																				
B2.3. Digital Twin and Point cloud integration into AR and VR interface	UOC																																				
C. Data Collection, Measurement and Evaluation Activities																																					
C1. Data Collection																																					
C1.1. Definition of data collection procedure	MOS																																				
C1.2. XYZ coordinates	MOS																																				
C1.3. Thermal information	MOS																																				
C1.4. RGB information	MOS																																				
C1.5. EGNSS location	MOS, MOBICS																																				
C2. Operation Testing																																					
C2.1. Testbed scenario S1.1	MOS, UOC																																				
C2.1.1. Drone flyover - photogrammetric	MOS																																				
C2.1.2. Flight data processing to obtain point cloud	MOS, UPM																																				
C2.1.3. DT Generation from point cloud data and connection to BIM model	MOS, UOC																																				
C2.1.4. DT connection with EGNSS data	UOC, MOBICS																																				
C2.1.5. Development of the functionality enabling visualisation of the DT with all the data mentioned in MR	UOC																																				
C2.2. Testbed scenario S1.2																																					
C2.2.1.Preparation of as-designed BIM model and 4D BIM model	MOS, UOC																																				
C2.2.2. Drone flyover - photogrammetric	MOS, UOC																																				
C2.2.3. Flight data processing to obtain point cloud	UOC																																				
C2.2.4. Algorithm development/testing on the comparison of 4D as-designed BIM model and the registered point cloud model	UOC																																				
C2.2.5. Verification on the algorithm to generate the outcome of the comparison of point cloud model and as-designed BIM model	UOC																																				
C2.2.6. Visualisation of the Digital Twin model and BIM model in VR/AR interface	UOC																																				
C2.3. Testbed scenario S1.3	UOC																																				
C2.3.1. Drone flyover - photogrammetric	MOS, UOC																																				
C2.3.2. Flight data processing to obtain point cloud	MOS, UPM																																				
C2.3.3. DT reconstruction based on the collected point cloud model with the location information of MEP terminal devices, equipment and its service scope	UOC																																				
C2.3.4. Analysis of the relevant spatial relationship of the MEP terminal devices and the equipment in the Digital Twin context	UOC																																				
C2.3.5. Creation of the hidden objects in the DT and visualisation in the VR/AR interface	UOC																																				
C2.4. Testing results of building element detection	UOC																																				
C2.5. Testing results of building element detection and object relationships	UOC																																				
C2.6. Visualization testing	UOC																																				
C3. Pilot Results/KPIs Calculation & Assessment	MOS, UOC																																				
D. Reporting Activities																																					
D.1 Pilot-related Deliverables	MOS, UOC													D4.1				D4.2										D4.3							D4.4		

WP4 Relevant Milestones (MS)
Relevant Technology Releases (TRs)
Other Contractual Milestones / Deliverables

aaaaa Deleted
Not fullfilled
New scheduling
Significant milestone (with description)
To define

3.1.1 Pilot 2

3.1.1.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 1.4

Table 9. Operation testing for the (SE1, Pilot 2) case (test scenario S1.4).

Scenario ID	S1.4
Developer	UOC
Pilot	City of Riga, Latvia [RPR]
Related Use Case	UC1.1
Objective	The objective of this scenario is to test the generation of the Digital Twin of a building from locally sourced geometry data. The chosen building is located separately from other buildings, therefore, quality terrestrial scanning data are available for all building parts. This building was chosen because it is a municipality building and, in the next few years, it will be renovated. In addition, there was already available scanning data for this building.
Location	Kaļķu iela 1, City of Riga (Old town), Latvia Cadastral number: 01000070142001 Coordinates: 24,1048711°E 56.9470690°N.
Scale Scope	Building (*Figure 8*) Area: 3064,64 m^2
Data	Cadastral data (building footprint), Merged point cloud of aerial laser scanning and terrestrial laser scanning (2022) with geo-location data and RGB information.
Resources	-
Workflow	1. Data collection. 2. Data processing to obtain point cloud with RGB data. 3. Integration of external point clouds. 4. DT generation.

Additional Considerations	The technical specifications for the data collection within SE1 operation testing are presented in D4.1 (Appendix III and Appendix IV).

Figure 8. Building delineation for the (SE1, Pilot 4) operation testing .

3.1.1.2 Pre-Pilot Phase. Progress

To ensure the creation of the Digital Twin for SE1, the appropriate building was selected, which had to meet certain criteria - 1. municipal building, 2. accessible and relevant data to ensure the creation of the DT, 3. a building that is not enclosed by obstacles such as trees or other buildings, 4. The building which is planned to be renovated. Considering the above, the building at 1 Kalķu Street was selected. The owner of the building, the Property Department of the Riga City Council, was informed about the choice of the building and the planned action.

In order to provide the necessary data for the creation of the building, a contract for access and use of the data was concluded between RPR and the data maintainers. The data was provided to the UOC.

1 online meeting with UOC was organized where the progress of the DT development was presented.

Changes made to the table:

1. Activities B2.2 ‘Provision of AR/VR interface’ and B2.3 ‘DT and Point cloud integration into AR and VR interface’ have been combined as both actions visualise the resulting digital twin in the AR/VR environment.
2. Description of activity C2.3 from ‘Testing results of building element detection and object relationships’ has been changed to ‘Testing results of building element relationships’, given that their meanings overlap.

Table 10. (SE1, Pilot 2) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress pre-pìlot phse	Data collected
	B. Infrastructure-related Activities			
	B1. Technology/Equipment/Building			
RPR	B1.1. Building selection	M11	Completed	Former Riga Technical University
	B2. Tool/Platform/Service Deployment/integration			
UOC, MOBICS	B2.1. EGNSS integration into building-scale model	M23	In progress	
UOC, MOBICS	B2.1. EGNSS integration into building-scale model	M23	In progress	
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
RPR	C1.1. Definition of data collection procedure	M11	Completed	Data requested (it was decided to choose a building with the existing laser scanning data of the municipality)
RPR	C1.2. XYZ coordinates	M13	Completed	Data (Point Cloud Data of target building and surrounding buildings) obtained from the municipality of Riga and provided to the UOC
RPR	C1.3. RGB information	M11	Completed	Data (RGB data of the target building) obtained from the municipality of

				Riga and provided to the UOC
RPR, MOBICS	C1.4. EGNSS location			
	C2. Operation Testing			
	C2.1. Testbed scenario S1.4			
RPR, UOC, MOBICS	C2.1.1. Data collection			
UOC, RPR	C2.1.2. Point cloud with RGB data	M11	Completed	Point cloud data with RGB values for selected building provided to UOC
UOC, MOBICS	C2.1.3. Integration of EGNSS service	M24	In progress	
UOC	C2.1.4. DT generation	M22	In progress	DT created. Alogrithm is being improved
UOC	C2.2. Testing results of building element detection	M22	In progress	The IFC element is generated for walls, windows and openings. Algorithm is being improved
UOC	C2.3. Testing results of building element relationships	M22	In progress	Spatial relationship between wall, opening and window have been built. Algorithm is being improved.
UOC	C2.4. Visualization testing	M27	In progress	

Table 11. (SE1, Pilot 2) Progress of tasks in the pre-pilot phase related to Gantt Chart

Service: SE1 | Pilot Partner: RPR Contributor: UOC | Other Partners Involved: MOBICS		2023												2024												2025								
														Pre-Pilot Phase				Full-Pilot Operation Phase																
																		Large-Scale Operation Phase																
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
Streams of Activities **WP4 & Project-level** **Pilot-related Milestones**	**Responsible Partner**												1st TR				MS 5				2nd TR						MS 7		Final TR					MS 10		
A. Preparation Activities																																				
A1. Pilot Engagement & Implementation Plan Design/Update	UOC,RPR																																			
A2. Pilot Scenarios Identification	UOC, RPR																																			
A3. KPIs Definition/Update (if needed)	RPR, UOC																																			
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B. Infrastructure-related Activities																																				
B.1 Technology/Equipment/Building	RPR																																			
B1.1. Building selection	RPR																																			
B2. Tool/Platform/Service Deployment/Integration	UOC																																			
B2.1. EGNSS integration into building-scale model	UOC, MOBICS																																			
B2.2. Provision of AR/VR interface	UOC																																			
B2.3. DT and Point cloud integration into AR and VR interface	UOC																																			
C. Data Collection, Measurement and Evaluation Activities																																				
C1. Data Collection	RPR, MOBICS																																			
C1.1. Definition of data collection procedure	RPR																																			
C1.2. XYZ coordinates	RPR																																			
C1.3. RGB information	RPR																																			
C1.4. EGNSS location	RPR, MOBICS																																			
C2. Operation Testing	UOC, RPR																																			
C2.1. Testbed scenario S1.4	RPR, UOC, MOBICS																																			
C2.1.1. Data collection	RPR, UOC, MOBICS																																			
C2.1.2. Point cloud with RGB data	UOC, RPR																																			
C2.1.3. Integration of EGNSS service	UOC, MOBICS																																			
C2.1.4. DT generation	UOC																																			
C2.2. Testing results of building element detection	UOC																																			
C2.3. Testing results of building element relationships	UOC																																			
C2.4. Visualization testing	UOC																																			
C3. Pilot Results/KPIs Calculation & Assessment	RPR, UOC																																			
D. Reporting Activities																																				
D.1 Pilot-related Deliverables	RPR, UOC												D4.1				D4.2										D4.3							D4.4		

WP4 Relevant Milestones (MS)
Relevant Technology Releases (TRs)
Other Contractual Milestones / Deliverables

aaaaa Deleted
Not fullfilled
New scheduling
Significant milestone (with description)
To define

3.1.2 Pilot 3

The engagement and implementation plan of the (SE1, Pilot 3) case is presented in Table 12**¡Error! No se encuentra el origen de la referencia.**.

3.1.2.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 1.5

Table 12. Operation testing for the (SE1, Pilot 3) case (test scenario S1.5).

Scenario ID	S1.5
Developer	UOC
Pilot	Municipality of Piraeus, Greece [MoP]
Related Use Case	UC1.1
Objective	The objective of this scenario is the generation of the Digital Twin of a building from locally sourced geometry data, as well as formation of the functionality to enable human-information interaction between users and Digital Twin in mixed reality. BIM models, indispensable for the development of the corresponding service, are available for this building. The scenario would enable defining relationships between objects and using this information to infer hidden objects if the indoor scanning is covered in this pilot project.
Location	Louka Ralli 99, Pireas, 21st Elementary School building of Piraeus, Coordinates: 37.9416857,23.6517284.
Scale Scope	Building (Figure 9) Total net area: almost 675 m^2 Plot area: around 1625 m^2
Data	Geo-location data (XYZ): by utilizing EGNSS for precise geo-referencing, RGB information: color mapping on the point cloud for realistic texture and detail, Thermal information (t): thermal imaging for identifying thermal patterns and insulation issues.

Resources	VR goggles, Trimble Real Works, Autodesk Recap, Unity Reflect, Twin View, 3Ddeling, TrueScan
Workflow	1. DT generation from point cloud data, 2. Connection of Digital Twin with EGNSS data, 3. Algorithm development/testing for defining relationships between mentioned objects. Using this information it is able to infer hidden objects (for example: pipe segment hidden behind a plaster wall), 4. Development of MR/ VR visualisation.
Additional Considerations	The technical specifications for the data collection within SE1 operation testing are presented in D4.1 (Appendix III and Appendix IV).

Figure 9.Building selection for the (SE1, Pilot 3) operation testing.

3.1.2.2 Pre-Pilot Phase. Progress

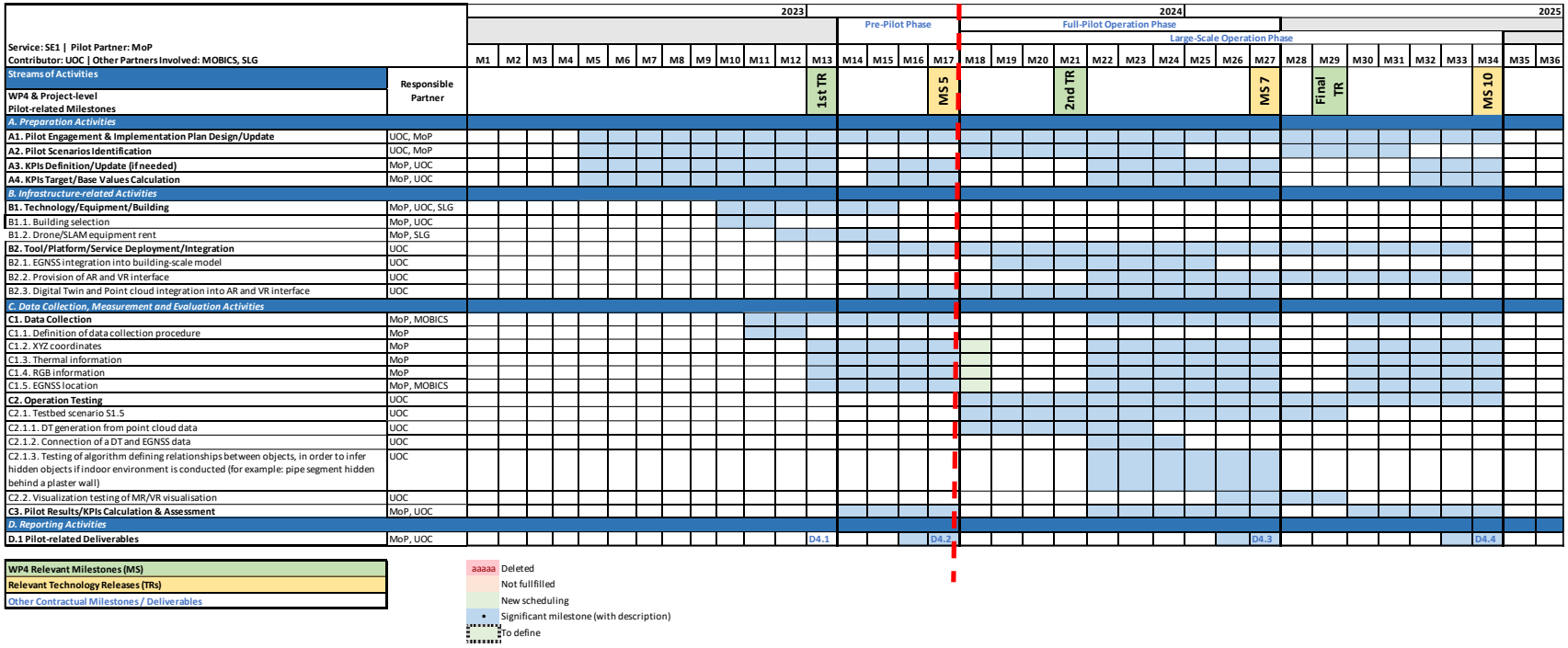
The selection of the building was finalized after extensive discussions between the service leaders, the project coordinators, and the Municipality of Piraeus. These discussions ensured that all project requirements were met and that the pilot was optimized for success. The chosen building (21st Elementary School of Piraeus) meets all the criteria necessary for the development of the Digital Twin and the

associated mixed reality functionalities. Regarding the data collection flights, they were postponed to June/July, due to procedural delays. The decision to delay was made in May, acknowledging the impracticality of conducting flights during the autumn conditions initially planned. Therefore, the measurements will now reflect summer conditions, which may offer different insights and benefits for the project.

Table 13. (SE1, Pilot 3) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress pre-pìlot phse	Data collected
	B. Infrastructure-related Activities			
	B1. Technology/Equipment/Building			
MoP, UOC	B1.1. Building selection	M11	Completed	21st Elementary School of Piraeus' building
MoP, SLG	B1.2. Drone/SLAM equipment rent	M17	New Scheduling	Postponed to June
	B2. Tool/Platform/Service Deployment/integration			
UOC	B2.1. EGNSS integration into building-scale model	M15 - M33	In progress	
UOC	B2.2. Provision of AR and VR interface	M22 - M33	In progress	
UOC	B2.3. Digital Twin and Point cloud integration into AR and VR interface	M15 - M27	In progress	
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
MoP	C1.1. Definition of data collection procedure	M12 - M13	Completed	MoP
MoP	C1.2. XYZ coordinates	M13 - M18	In progress	MoP
MoP	C1.3. Thermal information	M13 - M18	In progress	MoP
MoP	C1.4. RGB information	M13 - M18	In progress	MoP
	C2. Operation Testing			
	C2.1. Testbed scenario S1.5			
UOC	C2.1.1. DT generation from point cloud data	M18 - M23	In progress	
UOC	C2.1.2. Connection of a DT and EGNSS data	M22 - M25	In progress	
UOC	C2.1.3. Testing of algorithm defining relationships between objects, in order to infer hidden objects if indoor environment is conducted (for example: pipe segment hidden behind a plaster wall)	M22 - M27	In progress	
UOC	C2.2. Visualization testing of MR/VR visualisation	M26 - M29	In progress	

Table 14. (SE1, Pilot 3) Gantt Chart progress. Pre-Pilot phase



3.1.3 Pilot 4

3.1.3.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 1.6

Table 15. Operation testing for the (SE1, Pilot 4) case.

Scenario ID	S1.6
Developer	UOC
Pilot	Ljubljana, Slovenia [IMZI]
Related Use Case	UC1.1
Objective	The objective of this scenario is to test the DT generation for a building by using locally sourced geometric data.
Location	Ljubljana, Večna pot 113, The FKKT-FRI building of the University of Ljubljana, Coordinates: 46.0507762832196, 14.467761899558713
Scale Scope	Building (Figure 10**¡Error! No se encuentra el origen de la referencia.**), Total net area: 31530 m^2.
Data	Geo-location Data (XYZ): Utilizing EGNSS for precise geo-referencing, RGB Information (RGB): Color mapping on the point cloud for realistic texture and detail.
Resources	Hardware: Drone equipped with RGB camera and GPS (DJI Phantom 4 RTK or DJI Matrice M300 RTK with Zenmuse P1 camera (35mm)) (georeferenced) for the external envelope. Software: Agisoft Metashape Pro.
Workflow	1. Data collection, 2. Flight data processing to obtain point cloud with RGB data, 3. Integration of external point clouds, 4. DT generation.

Additional Considerations	The technical specifications for the data collection within SE1 operation testing are presented in D4.1 (Appendix III and Appendix IV).

3.1.3.2 Pre-Pilot Phase. Progress

The Gantt Chart of Pilot 4 (The FKKT-FRI building of the University of Ljubljana) for Service 1 hasn't been modified.

During the pre-pilot phase, the IMZI, as pilot, has actively engaged with the technical partner UOC to identify and collect the required data at building level for Use Case 1.1. Efforts are ongoing to finalise the EGNSS location.

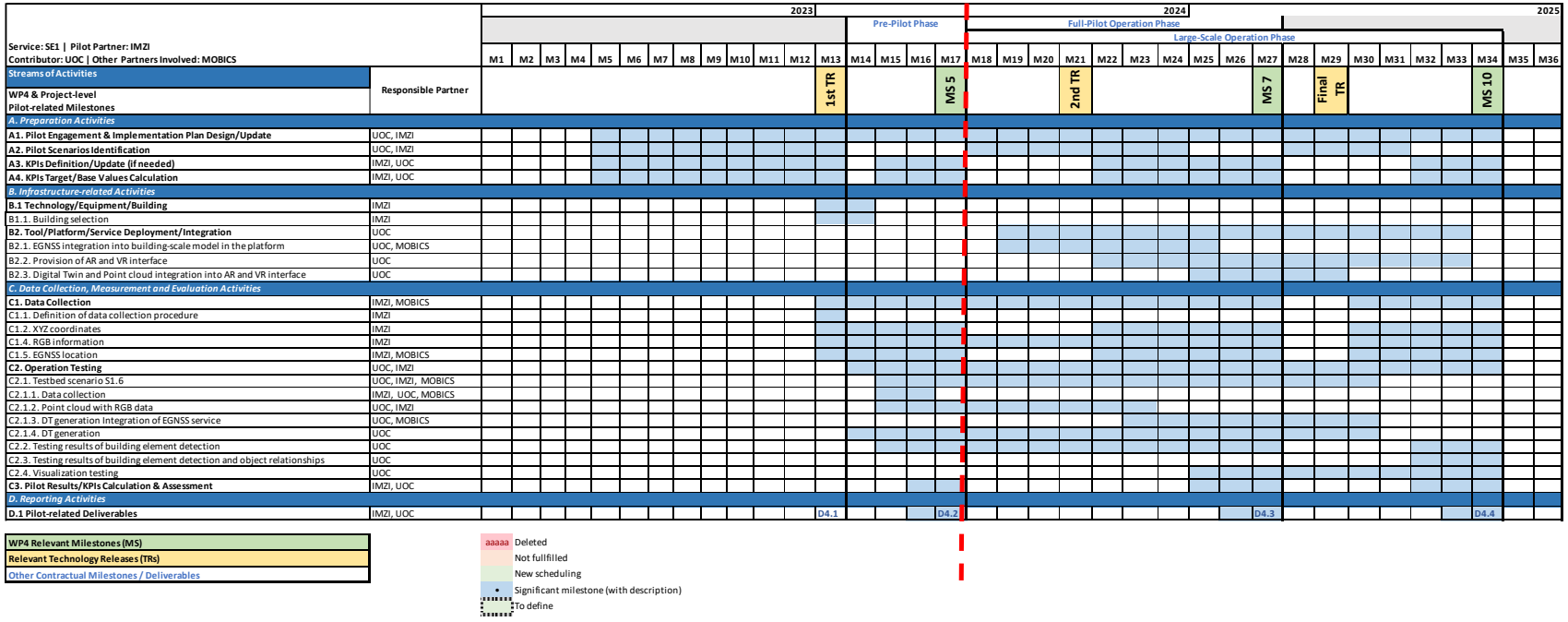
Table 16. (SE1, Pilot 4) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress pre-pilot phase	Results
	B. Infrastructure-related Activities			
	B.1 Technology/Equipment/Building			
IMZI	B1.1. Building selection	M13	Completed	The FKKT-FRI building of the University of Ljubljana
	B2. Tool/Platform/Service Deployment/Integration			
UOC, MOBICS	B2.1. EGNSS integration into building-scale model in the platform	M19 - M25		
UOC	B2.2. Provision of AR and VR interface	M22 - M33		
UOC	B2.3. Digital Twin and Point cloud integration into AR and VR interface	M25 - M29		
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
IMZI	C1.1. Definition of data collection procedure	M13	Completed	specifications
IMZI	C1.2. XYZ coordinates	M14	Completed	Coordinates of GCPs (EPSG 3794 horizontal and EPSG 10246 vertical)
IMZI	C1.4. RGB information	M14	Completed	Photogrammetry images of P1 and P4RTK sensors, Panoramic images

				and flyovers (P1 > 3_misc folder),
IMZI, MOBICS	C1.5. EGNSS location	M13 - M17	Completed	Positions (lat, long and altitude)
	C2. Operation Testing			
	C2.1. Testbed scenario S1.6			
IMZI, UOC, MOBICS	C2.1.1. Data collection	M14	Completed	point cloud in PLY format, 3D model (mesh) in OBJ format, orthophoto in JPG
UOC, IMZI	C2.1.2. Point cloud with RGB data	M14	Completed	point cloud data in .ply and .obj formats
UOC, MOBICS	C2.1.3. DT generation Integration of EGNSS service	M23 - M30		
UOC	C2.1.4. DT generation	M14 - M17	In progress	
UOC	C2.2. Testing results of building element detection	M15 - M17	In progress	
UOC	C2.3. Testing results of building element detection and object relationships	M32 - M34		
UOC	C2.4. Visualization testing	M25 - M34		

Figure 10. Building selection for the (SE1, Pilot 4) operation testing.

Table 17. (SE1, Pilot 4) Gantt Chart progress. Pre-Pilot phase



3.2 Service 2

3.2.0 Pilot 1

3.2.0.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 2.1

Table 18. Operation testing for the (SE2, Pilot 1) case.

Scenario ID	S2.1
Developer	UPM
Pilot	Warsaw, Poland [MOS]
Related Use Case	UC2.1
Objective	The objective of this scenario is to test the feasibility of dynamically controlling a building, with a focus on identifying anomalies in the envelope, particularly thermal bridges. The DT of the building will be enhanced with a functionality that utilizes thermal scanning data to identify and categorize thermal bridges, and the generation of a thermal bridges report will be enabled. Furthermore, thermal scanning will be employed to oversee the control of solar panel cells. The building chosen for the testbed scenario is newly constructed and heated; it also features a photovoltaic installation. All of the above aspects enable the identification of thermal bridges and the assessment of solar panel cell energy performance.
Location	Similar to S1.1
Scale Scope	Similar to S1.1
Data	Geo-location data (XYZ), RGB information (images), Thermal information (images).
Resources	Hardware: Drone equipped with thermal and RGB camera (UAV) and GPS (georeferenced) for the external envelope, and mobile mapping (SLAM) and GPS (georeferenced) for the inner envelope. Software:

	Pix4D, Agisoft Metashape, Reality capture, Context Capture or Drone Deploy, Manufacture SLAM software.
Workflow	1. Data collection, 2. Flight data processing to obtain the point cloud with RGB and thermal data, 3. Processing of the internal part of the building, 4. Integration of internal and external point clouds, 5. DT generation and connection to the BIM model (IFC), 6. Development and testing of the algorithm that uses delivered thermal scanning to identify thermal bridges and visualize them in the DT, 7. Development and testing of the algorithm that uses Machine Learning to categorize thermal bridges as connected to, for example: doors, windows, reinforced concrete slab ring beam, roof rafters, thermal insulation discontinuity, thermal insulation metal connectors, and building corners, 8. Development and testing of the report functionality concerning thermal bridges generation, 9. Development and testing of the algorithm that uses delivered thermal scan of external envelope of a building to control the quality of solar panel cells, categorizing them as: functioning and non-functioning (functioning at too low efficiency, for the complete panel, not cells), 10. Development and testing of the functionality concerning the generation of solar panel cells quality report generation.
Additional Considerations	- The technical specifications for the data collection within SE2 operation testing are presented in Appendix III and Appendix IV of D4.1. - The resolution of the image depends on the distance between the drone and the building, that is, on the ratio called GSD (Ground Sample Distance). Position the scanner at a distance that ensures the laser can capture the façade with the desired resolution. The overlap of at least 20-30% is required between consecutive scans to provide enough common data points for accurate registration. The overlap may need to be increased for complex geometries or when scanning intricate detail. Conduct a grid-based approach by dividing the façade into sections that each scan will cover, considering the overlap. Use a consistent pattern for scanning, such as top to bottom and left to right, to maintain organization.

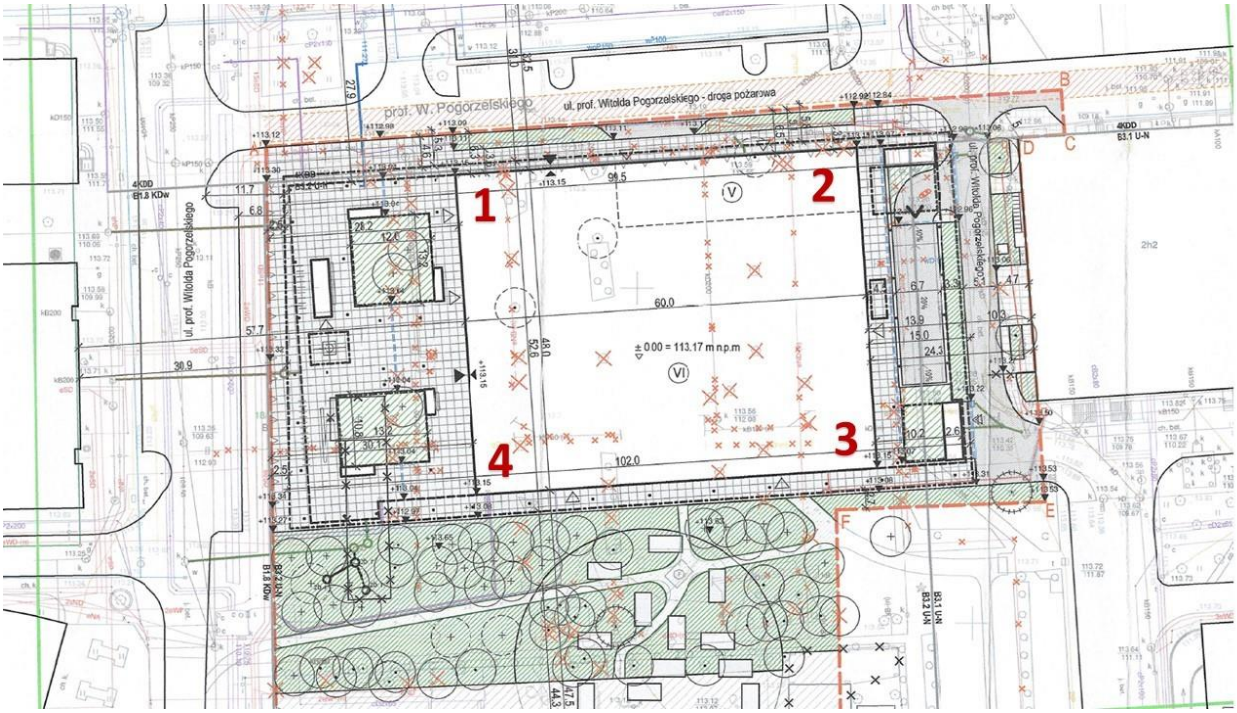


Figure 10. Building delineation for the conduction of scenario S1.1.

3.2.0.2 Pre-Pilot Phase Progress

The Gantt Chart of Pilot 1 for Service 2 has been modified. In M12 MOS conducted first test drone flyover of the exterior part of a building during which the RGB data was collected.

In M14 MOS with UPM support conducted the official drone flight during which RGB (photogrammetry) and thermal information with higher resolution (C1.2 and C1.3) was collected. Both were delivered to UPM with its corresponding metadata (C1.7) and georeferenced points localized in accordance with System 2000 zone 7 (EPSG 2178) (C1.6). This flight was optimal for the RGB processing (reconstruction), therefore this data will be used as a point cloud for the development of the digital twin. Due to the insufficient difference in temperature between the exterior and interior of the building (unusually high temperatures in Warsaw earlier than usual), the thermal data could not be used for the thermal projection of the texture (C2.1.1). It was decided that the thermal data collected during this drone flight will serve as a database for the development of activities C2.1.4 to C2.1.7. Additionally, the new thermal drone flight to deliver useful thermal data was planned for M23-M25 (between November ’24 and January ’25).

As the flights have been postponed, tasks C2.1.5 to C1.2.8 have been brought forward using the February flight and other own databases.

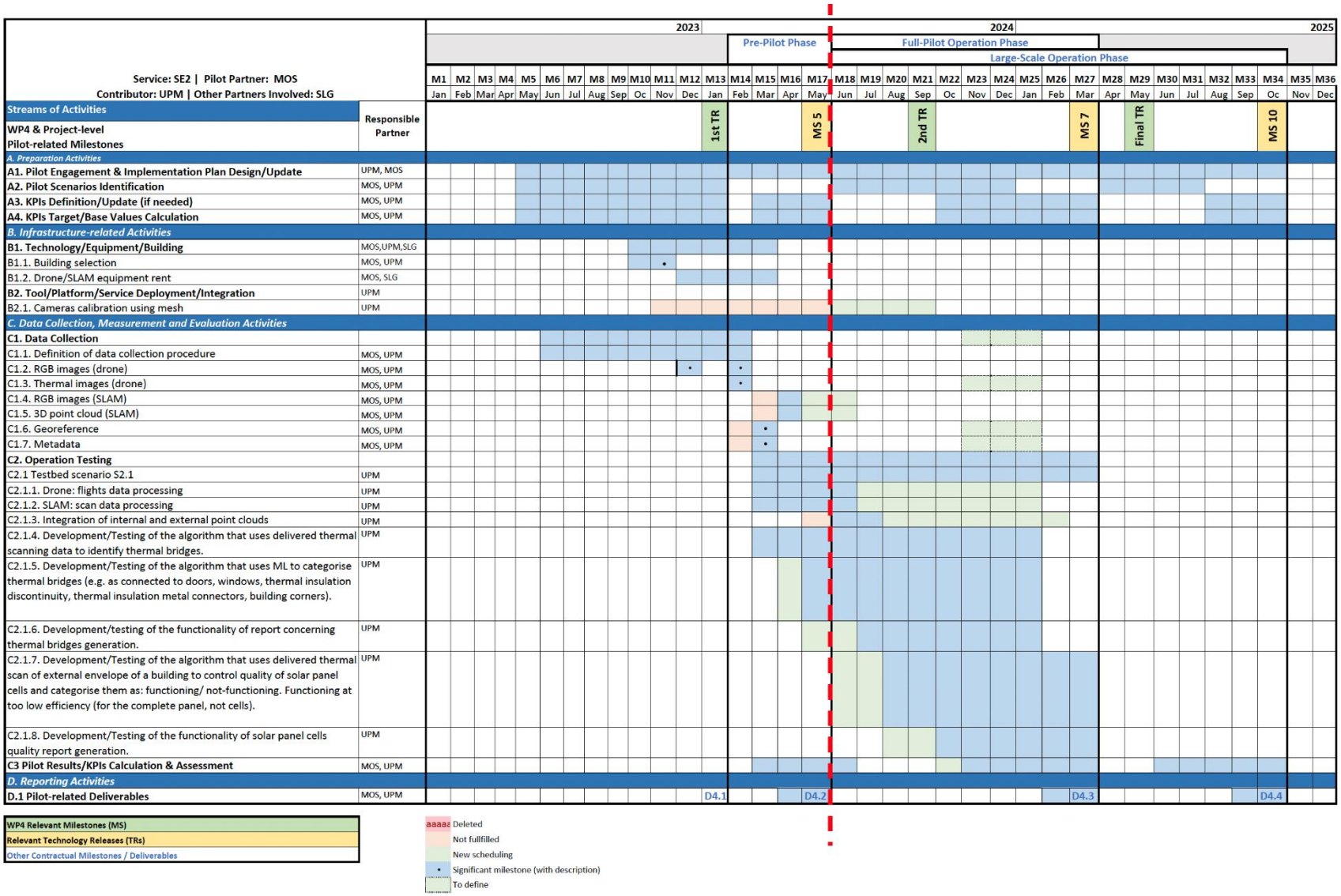
Laser scanning activities of interior and partly exterior of the Pilot building have started along with the Gantt Chart and are still ongoing. SLAM data will likely be delivered to UPM on M18 (C1.4).

Table 19. (SE2, Pilot 1) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress pre-pilot phse	Data collected
	B. Infrastructure-related Activities			
	B1. Technology/Equipment/Building			
MOS, UPM	B1.1. Building selection	M11	Completed	Faculty of Psychology of the University of Warsaw
MOS, SLG	B1.2. Drone/SLAM equipment rent	M14	Completed	Drone
		M16	Completed	SLAM
	B2. Tool/Platform/Service Deployment/Integration			
UPM	B2.1. Camera calibration using mesh	M11 - M21	In discussion	Confidentiality document during legal consultations
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
MOS, UPM	C1.1. Definition of data collection procedure	M6 – M14	Completed	
MOS, UPM	C1.2. RGB images (drone)	M11	Completed	3643 images
		M14	Completed	4146 images
		M23 – M25	New Scheduling	
MOS, UPM	C1.3. Thermal images (drone)	M14	Completed	3643 images
		M23 – M25	New Scheduling	
MOS, UPM	C1.4. RGB images (SLAM)	M16-M18	New scheduling	
MOS, UPM	C1.5. 3D point cloud (SLAM)	M16 - M18	New scheduling	
MOS, UPM	C1.6. Georeference	M14	Completed	17 points (drone)
		M16 - M18	New Scheduling	(SLAM)
		M23 – M25	New Scheduling	(drone)
MOS, UPM	C1.7. Metadata	M14	Completed	Weather, coordinates system

		M18	New Scheduling	(SLAM)
		M23 – M25	New Scheduling	(drone)
	C2. Operation Testing			
	C2.1 Testbed scenario S2.1			
UPM	C2.1.1. Drone: flights data processing	M15 – M25	In progress	
UPM	C2.1.2. SLAM: scan data processing	M15 – M25		
UPM	C2.1.3. Integration of internal and external point clouds	M15 – M26	New Scheduling	No SLAM data available
UPM	C2.1.4. Development/Testing of the algorithm that uses delivered thermal scanning data to identify thermal bridges.	M15 – M25	In progress	
UPM	C2.1.5. Development/Testing of the algorithm that uses ML to categorise thermal bridges (e.g. as connected to doors, windows, thermal insulation discontinuity, thermal insulation metal connectors, building corners).	M16 – M25	In progress	
UPM	C2.1.6. Development/testing of the functionality of report concerning thermal bridges generation.	M17 – M25	In progress	
UPM	C2.1.7. Development/Testing of the algorithm that uses delivered thermal scan of external envelope of a building to control quality of solar panel cells and categorise them as: functioning/ not-functioning. Functioning at too low efficiency (for the complete panel, not cells).	M18 – M27	New Scheduling	Brought forward
UPM	C2.1.8. Development/Testing of the functionality of solar panel cells quality report generation.	M20 – M27	New Scheduling	Brought forward

Table 20. (SE2, Pilot 1) Gantt Chart progress. Pre-Pilot phase



3.2.1 Pilot 3

3.2.1.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 2.2

Table 21. Operation testing for the (SE2, Pilot 3) case.

Scenario ID	S2.2
Developer	UPM
Pilot	Municipality of Piraeus, Greece [MoP]
Related Use Case	UC2.1
Objective	The objective of this scenario is to identify areas of intervention in a municipal building, with a focus on identifying anomalies in the envelope, particularly thermal bridges. The Digital Twin of the building will be enhanced with functionality utilising thermal scanning data to identify and categorise critical areas, and the generation of a critical areas report will be enabled.
Location	Similar to S1.5.
Scale Scope	Similar to S1.5.
Data	Similar to S1.5.
Resources	Similar to S1.5.
Workflow	1. Data collection, 2. Flight data processing to obtain point cloud with RGB and thermal data, 5. DT generation and connection to the BIM model (IFC), 6. Development and testing of the algorithm that uses delivered thermal scanning data to identify critical areas and visualise them in the DT, 7. Development and testing of the algorithm that uses ML to categorise critical areas as connected to, for example: thermal bridges and type, dampness on the wall, 8. Development and testing of the functionality of report concerning critical areas generation.
Additional Considerations	Similar to S1.5.

3.2.1.2 Pre-Pilot Phase. Progress

The Gantt Chart of Pilot 3 for Service 2 has been modified. The drone calibration, which was in charge of the UPM, is deleted because the company hired to carry out the flights has the necessary parameters to correct the images, and calibration will not be necessary (B2.1). The RGB and thermo flights were postponed to June/July because, although they were established in January/February, the procedures to carry them out were excessively delayed until May, therefore, it was decided to move the flights to summer and replace the measurements of winter condition with summer conditions (C1.2 and C1.3. with C1.4 and C1.5).

Regarding the SLAM, it was decided to eliminate it since the benefits offered by the service did not meet the requirements of the pilot, remaining scarce since the budget was very tight.

As the flights have been postponed, tasks C2.1.5 and C1.2.6 have been brought forward using the Poland flight and other own databases to develop them.

Table 22. (SE2, Pilot 3) Progress of tasks in the pre-pilot phase related to Gantt Chart.

Responsible Partner	Streams of Activities	Month	Progress pre-pìlot phse	Data collected
	B. Infrastructure-related Activities			
	B1. Technology/Equipment/Building			
MoP, UPM	B1.1. Building selection	M11	Completed	21st Elementary School building of Piraeus
MoP, SLG	B1.2. Drone/SLAM equipment rent	M18	New Scheduling	Postponed to June
	B2. Tool/Platform/Service Deployment/Integration			
UPM	B2.1. Cameras calibration using mesh		Deleted	The company in charge of the flight will calibrate the drone.
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
MoP, UPM	C1.1. Definition of data collection procedure	M6 - M19	In progress	
MoP, UPM	C1.2. RGB images (drone)	M18 - M19	New Scheduling	Postponed to June
MoP, UPM	C1.3. Thermal images (drone)	M18 - M19	New Scheduling	Postponed to June
MoP, UPM	C1.4. RGB images (SLAM)		Deleted	
MoP, UPM	C1.5. 3D point cloud (SLAM)		Deleted	
MoP, UPM	C1.4. Georeference	M18 - M19	New Scheduling	Postponed to June

MoP, UPM	C1.5. Metadata	M18 - M19	New Scheduling	Postponed to June
MoP, UPM	C1.1. Definition of data collection procedure	M6 - M19	In progress	
MoP, UPM	C1.2. RGB images (drone)	M18 - M19	New Scheduling	Postponed to June
	C2. Operation Testing			
	C2.1. Testbed Scenario S2.2			
UPM	C2.1.1. Drone: flights data processing	M18 - M23	New Scheduling	Postponed to June
UPM	C2.1.2. SLAM: scan data processing		Deleted	
UPM	C2.1.3. Integration of internal and external point clouds		Deleted	
UPM	C2.1.4. Development/Testing of the algorithm that uses delivered thermal scanning data to identify critical areas and visualise them in DT.	M15 – M26		
UPM	C2.1.5. Development/Testing of the algorithm that uses ML to categorise critical areas (e.g. as connected to thermal bridges and type, dampness on the wall).	M16 - M26	New Scheduling	Brought forward
UPM	C2.1.6. Development/testing of the functionality of report concerning critical areas generation.	M17 - M26	New Scheduling	Brought forward

Table 23. (SE2, Pilot 3) Gantt Chart progress. Pre-Pilot phase

Service: SE2 | Pilot Partner: MoP Contributor: UPM | Other Partners Involved: SLG		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oc	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oc	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oc	Nov	Dec
Streams of Activities **WP4 & Project-level Pilot-related Milestones**	Responsible Partner													1st TR				MS 5				2nd TR						MS 7				Final TR					MS 10		
A. Preparation Activities																																					
A1. Pilot Engagement & Implementation Plan Design/Update	UPM, MoP																																				
A2. Pilot Scenarios Identification	MoP, UPM																																				
A3. KPIs Definition/Update (if needed)	MoP, UPM																																				
A4. KPIs Target/Base Values Calculation	MoP, UPM																																				
B. Infrastructure-related Activities																																					
B1. Technology/Equipment/Building	MoP,UPM,SLG																																				
B1.1. Building selection	MoP, UPM																																				
B1.2. Drone/SLAM equipment rent	MoP, SLG																																				
B2. Tool/Platform/Service Deployment/Integration	UPM																																				
B2.1. Cameras calibration using mesh	UPM																																				
C. Data Collection, Measurement and Evaluation Activities																																					
C1. Data Collection	MoP, UPM																																				
C1.1. Definition of data collection procedure	MoP, UPM																																				
C1.2. RGB images (drone)	MoP, UPM																																				
C1.3. Thermal images (drone)	MoP, UPM																																				
C1.4. RGB images (SLAM)	MoP, UPM																																				
C1.5. 3D point cloud (SLAM)	MoP, UPM																																				
C1.4. Georeference	MoP, UPM																																				
C1.5. Metadata	MoP, UPM																																				
C2. Operation Testing	MoP, UPM																																				
C2.1. Testbed Scenario S2.2	UPM																																				
C2.1.1. Drone: flights data processing	UPM																																				
C2.1.2. SLAM: scan data processing	UPM																																				
C2.1.3. Integration of internal and external point clouds	UPM																																				
C2.1.4. Development/Testing of the algorithm that uses delivered thermal scanning data to identify critical areas and visualise them in DT.	UPM																																				
C2.1.5. Development/Testing of the algorithm that uses ML to categorise critical areas (e.g. as connected to thermal bridges and type, dampness on the wall).	UPM																																				
C2.1.6. Development/testing of the functionality of report concerning critical areas generation.	UPM																																				
C3 Pilot Results/KPIs Calculation & Assessment	MoP, UPM																																				
D. Reporting Activities																																					
D.1 Pilot-related Deliverables	MoP, UPM													D4.1				D4.2										D4.3							D4.4		

WP4 Relevant Milestones (MS)
Relevant Technology Releases (TRs)
Other Contractual Milestones / Deliverables

aaaaa Deleted
Not fullfilled
New scheduling
drone flight

4 BUILDSPACE Monitoring. City Level Pilots Operation (T4.3)

This task will evaluate BUILDSPACE apps services at city level addressing urban stakeholders, namely SE3 Energy monitoring, forecast and climate resilience, SE4 Urban Heat analysis and resilience and SE5 Urban flood analysis. These services will be tested in Pilot 2 (Riga), Pilot 3 (Ljubljana) and Pilot 4 (Piraeus), respectively. This will enable to test the dimensions of Energy, Heat and Flood proposed by BUILDSPACE. This task will organize three live events, one per pilot, where external users will be invited in the real demonstration of the services.

T4.3 coordination activities

In order to monitor the implementation of the services at city level, additional columns were created in the Gantt chart for each pilot partner: 1) execution day, 2) development progress (%), 3) comments.

The updates and their purpose were presented in a joint online session with the service developers and the pilot partners, where the partners, in collaboration with the service developers, were asked to assess the subtasks and add new tasks during the development of the services, if necessary. The partners were asked to assess whether it is necessary to split the implementers of a service if more than one responsible partner is named in the implementation of a responsible task. The 'comments section' is intended to describe the progress or challenges of subtask implementation activities.

The pilots were asked to regularly update the Gantt chart and assess the progress of the tasks. In the light of this monitoring structure, the partners have updated the information in the Gantt chart according to the evolution of their services.

4.1 Service 3

4.1.0 Pilot 4

4.1.0.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who is the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 3.1

Table 24. Operation testing for the (SE3, Pilot 2) case (test scenario S3.1).

Scenario ID	S3.1
Developer	CARTIF
Pilot	City of Riga, Latvia [RPR]
Related Use Case	UC3.1
Objective	The objective of this scenario is to test the estimation of the energy demand for a set of buildings in a real but small area. Result: colored map with Latvian EPCs label colors for heating demand, cooling demand and DHW (kWh/m²·year).
Location	Neighborhood of City of Riga, Latvia, Coordinates: 24,0778207°E 56,9403477°N, Area code: 0100058.
Scale Scope	A city neighborhood including residential and other buildings. Area: 240 668 m² Cadastral number of buildings: 631
Data	Cadastral data GIS (footprint), Cadastral data XML (height, construction year, etc.), OpenStreetMap data, TABULA/EPISCOPE projects data, Energy efficiency coloring adapted according to Latvian EPC used colors for energy efficiency classes Weather data (temperatures) for a typical year.
Resources	Python, GIS tool for visualization.
Workflow	1. Gather all the input data and join the cadastral information from the different files, 2. Processing OSM data and join it with Cadastral data to process geometries, 3. Generating typology and other parameters (assigning use, assigning construction year, assigning characteristics and assigning solar radiation). 4. Calculating HDD and CDD, 5. Calculate energy demand (heating, cooling and DHW), 6. Assign Latvian EPC colors (label scale) to the calculated demand.
Additional Considerations	The accuracy of the service depends highly on the quantity and quality of the data used for the calculations.

Scenario 3.2

Table 25. Operation testing for the (SE3, RPR) case (test scenario S3.2).

Scenario ID	S3.2
Contributor	CARTIF, NTUA
Pilot	City of Riga, Latvia [RPR]
Related Use Case	UC3.3
Objective	The objective of this scenario is to test the PV potential assessment tool in a small-scale neighborhood and examine its accuracy level. The testbed neighborhood includes a variety of buildings, representing a suitable area. Functionalities: Rooftop area estimation (m^2), Usable Solar Radiation estimation (kWh/m^2), PV production estimation (kWh/m^2).
Location	Similar to S3.1.
Scale Scope	Similar to S3.1.
Data	Cadastral data (buildings footprint), Digital Surface model (1m resolution).
Resources	ArcGIS Pro 3.2, PVGIS tool, Global Solar Atlas.
Workflow	1. Create a geodatabase with the required data, 2. Implement the required data in ArcGIS Pro 3.2, 3. Exclude underground buildings and unsuitable areas from further evaluation (North facing rooftops, high slope areas, etc.), 4. Analysis of potential solar radiation with ArcGIS Pro 3.2, 5. Evaluation of the results with PVGIS tool.
Additional Considerations	The accuracy of the service depends highly on the resolution of the Digital Surface model and the georeferenced cadastral data, as well as the solar radiation properties of the area (time zone, diffusion radiation, etc.).

4.1.0.2 Pre-Pilot Phase. Progress

Services development for Pre-Pilot Phase are prepared for testing. Building data is obtained and prepared for implementation in service data package. The test area has been chosen, which is one of Riga's cadastral groups, containing 631 buildings. High resolution raster images, historical climatic data and building renovation measures with actualized prices for 2023 were shared for continuing the development of the next releases of the service. Building characterization and building energy demand calculation are completed for the small area chosen, the next step is to expand such characterization and calculations for

the whole city of Riga (all residential buildings). Real heat consumption data from the District Heating has been also shared to be used as input for the energy consumption calculation and to identify the buildings connected to the District Heating. Geo database is created, unsuitable buildings are excluded, ArcGIS data integrated. Solar radiation analysis is prepared and the first comparison with PVGIS model is fulfilled.
To increase usability of service new activities were added:

- Riga's Heritage building information;
- Detailed PV installation prices;
- District definition.

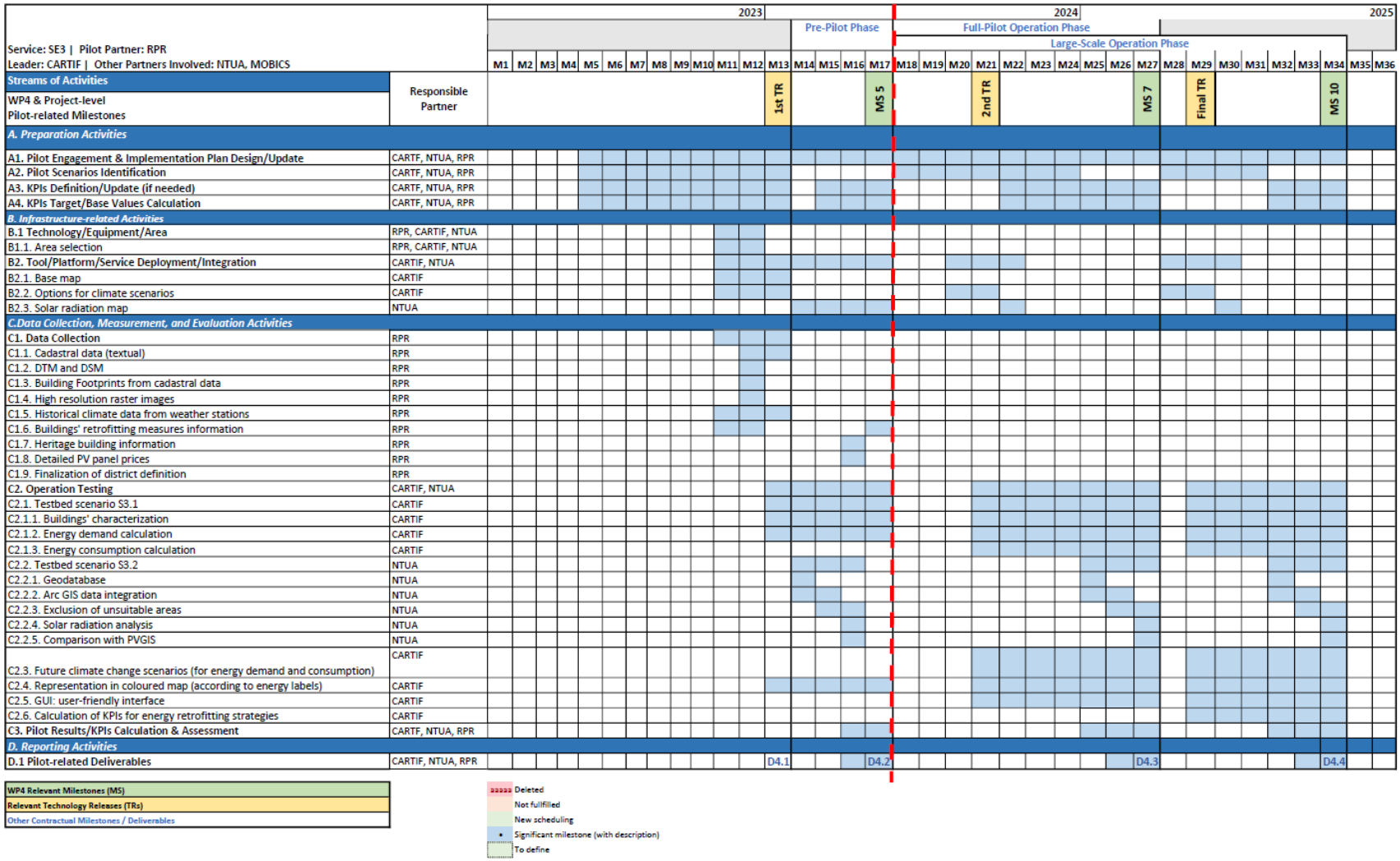
RPR provided PV installation prices can be better quality and could be replaced by more detailed ones. Implementation of public information about historic buildings is pending.

Table 26. (SE3, Pilot 2) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress	Results
	B. Infrastructure-related Activities			
	B.1 Technology/Equipment/Area			
RPR, CARTIF, NTUA	B1.1. Area selection	M10	Completed	
	B2. Tool/Platform/Service Deployment/Integration			
CARTIF	B2.1. Base map	M17	In progress	
CARTIF	B2.2. Options for climate scenarios	M21	In progress	
NTUA	B2.3. Solar radiation map	M22	In progress	
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
RPR	C1.1. Cadastral data (textual)	M10	Completed	
RPR	C1.2. DTM and DSM	M10	Completed	
RPR	C1.3. Building Footprints from cadastral data	M10	Completed	
RPR	C1.4. High resolution raster images	M10	In progress	Implementation for whole city area still in progress
RPR	C1.5. Historical climate data from weather stations	M10	Completed	
RPR	C1.6. Buildings' retrofitting measures information	M10	Completed	
RPR	C1.7. Heritage building information	M17	New task Completed	
RPR	C1.8. Detailed PV panel prices	M16	New task Completed	

RPR	C1.9. Finalization of district definition	M16	New task Completed	
CARTIF, MOBICS	C1.7. Copernicus data	M21	In progress	
	C2. Operation Testing			
CARTIF	C2.1. Testbed scenario S3.1	M12	Completed	
CARTIF	C2.1.1. Buildings' characterization	M12	Completed	
CARTIF	C2.1.2. Energy demand calculation	M12	Completed	
CARTIF	C2.1.3. Energy consumption calculation	M12	Completed	
	C2.2. Testbed scenario S3.2	M12	Completed	
NTUA	C2.2.1. Geodatabase		Completed	
NTUA	C2.2.2. Arc GIS data integration	M11	Completed	
NTUA	C2.2.3. Exclusion of unsuitable areas	M11	Completed	
NTUA	C2.2.4. Solar radiation analysis	M11	Completed	
NTUA	C2.2.5. Comparison with PVGIS	M27	In progress	Implementation for whole city area still in progress
CARTIF	C2.3. Future climate change scenarios (for energy demand and consumption)	M23	In progress	
CARTIF	C2.4. Representation in colored map (according to energy labels)	M22	In progress	
CARTIF	C2.5. GUI: user-friendly interface	M22	In progress	
CARTIF	C2.6. Calculation of KPIs for energy retrofitting strategies	M34	In progress	

Table 27. (SE3, Pilot 2) Gantt Chart progress. Pre-Pilot phase



4.2 Service 4

The engagement and implementation plan for the (SE4, Pilot 3) case is presented in D4.1 deliverable (in Table 24, Table 25, and Table 26). Due to the specific features of service SE4, the Gantt chart activities have been slightly modified. Moreover, scenario S4.1 is part of the whole operation activities; thus, it is not specifically mentioned in the timeline.

4.2.0 Pilot 3

4.2.0.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 4.1

Table 28. Operation testing for the (SE4, Pilot 3) case.

Scenario ID	S4.1
Developer	UPM, MOBICS
Pilot	Municipality of Piraeus, Greece [MoP]
Related Use Cases	UC4.1, UC4.2, UC4.3
Objective	The objective of this scenario is to test different procedures for calculating the urban heat risk, starting from a broader scale and then increasing the spatial and temporal resolution of the service on the forthcoming iterations.
Location	Athens metropolitan area and Municipality of Piraeus.
Scale Scope	Census scale for vulnerability analysis and Athens metropolitan area for urban heat analysis.
Data	Urban Audit, Urban Atlas, CWS, Copernicus Data: ERA5, Land Service, Atmospheric Service, Climate Change Service.
Resources	ArcGIS Pro, Python ID, Meteonorm, EnergyPlus.

Workflow	1. Identify open, standardized databases at EU level for hazard and vulnerability analysis, 2. Systematise the access to the datasets via APIs, 3. Pre-process the meteorological datasets (QA/QC procedures, metadata provision), 4. Pre-process the socio-economic datasets, 5. Pre-process the demographic datasets, 6. Database integration into the GIS platform, 7. Identify the areas with the higher vulnerability, hazard, exposure and risk to urban heat (hotspots).
Additional Considerations	-

4.2.0.2 Pre-Pilot Phase. Progress

During the pre-pilot phase, the Municipality of Piraeus (pilot) has actively engaged with the service providers to identify the required sociodemographic data at the urban level. Efforts are ongoing to obtain these data from available sources, ensuring that they are comprehensive and relevant for urban heat risk analysis.

The pilot is also working with CARTIF to gather the necessary data for calculating the energy demand of the building stock. This data is crucial for Service 4, as it will inform the urban heat risk calculations and contribute to a more accurate and detailed analysis.

UPM conducted a review of existing procedures for applying data quality control to CWS datasets. It has also tested the MetObs Toolkit for these procedures and gap filling techniques. For this purpose, a notebook has been created to facilitate the implementation of the first activities for the Hazard Assessment. In parallel, different interpolation methodologies have been explored in order to obtain the first preliminary urban heat maps.

Table 29. (SE4, Pilot 3) Progress of tasks in the pre-pilot phase related to Gantt Chart

Responsible Partner	Streams of Activities	Month	Progress pre-pìlot phase	Data collected
	B. Infrastructure-related Activities			
	B1. Technology/Equipment/Building			
UPM	B1.1. Hazard indicators	M14	Completed	
UPM, MOBICS, MoP	B1.2. Vulnerability indicators	M14	Completed	
UPM, MoP, MOBICS	B1.3. Exposure indicators	M14	In progress	
	B2. Open databases identification and integration			
MoP, UPM	B2.1. Hazard databases	M12-M18	In progress	

MoP, UPM, MOBICS	B2.2. Vulnerability databases	M14	In progress	
MoP, UPM	B2.3. Exposure databases	M14	In progress	
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Urban Heat Risk Assessment			
UPM	C1.1. Hazard Assessment	M15 - 27	New Scheduling	
UPM, MOBICS	C1.2. Vulnerability Assessment	M14 - M27	New Scheduling	
UPM	C1.3. Exposure Assessment	M15 - M17	New Scheduling	
UPM	C1.4. Urban Heat Risk Hotspots	M17 / M27	New Scheduling	
CARTIF	**C2. Building energy profiles**			
CARTIF	C2.1 Calculation of energy demand for a district	M12 - M21	New Scheduling	
CARTIF	C2.2 Calculation of energy demand within a risk hotspot (M27)	M21 – M29	New Scheduling	
CARTIF	C2.3 Calculation of energy demand for the city (M34)	M25-M34	New Scheduling	
UPM	**C3. Mitigation and Adaptation Solutions**	M23 - M32	New Scheduling	

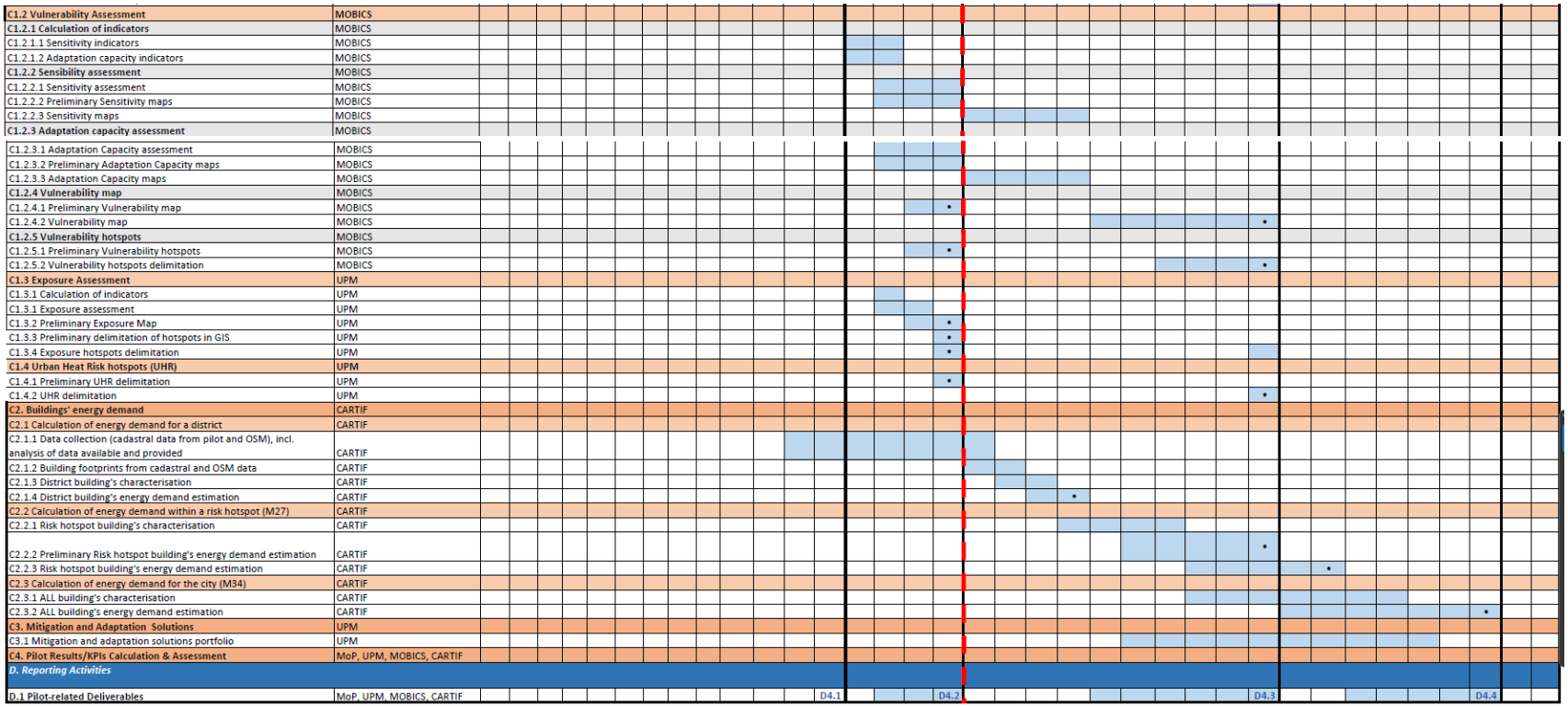
Table 30. (SE4, Pilot 3) Gantt Chart progress. Pre-Pilot phase

Streams of Activities WP4 & Project-level Pilot-related Milestones	Responsible Partner	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
														1st TR				MS 5				2nd TR										MS 7		Final TR						MS 10		
A. Preparation Activities																																					
A1. Pilot Engagement & Implementation Plan Design/Update	UPM, MoP																																				
A2. Pilot Scenarios Identification	UPM, MoP																																				
A3. KPIs Definition/Update (if needed)	UPM, MoP, MOBICS, CARTIF																																				
A4. KPIs Target/Base Values Calculation	MoP, UPM, MOBICS, CARTIF																																				
B. Data selection & Storage																																					
B1. Indicators Selection	UPM, MOBICS																																				
B1.1 Hazard indicators	UPM																																				
B1.2 Vulnerability indicators	UPM, MOBICS, MoP																																				
B1.3 Exposure indicators	UPM, MoP, MOBICS																																				
B2. Open databases identification and integration	MoP, UPM, MOBICS																																				
B2.1 Hazard databases	MoP, UPM																																				
B2.1.1 ERA5	UPM																																				
B2.1.1.1 ERA5 data download	UPM																																				
B2.1.2 CWS	UPM																																				
B2.1.2.1 CWS data download	UPM																																				
B2.1.2.2 QC/QA	UPM																																				
B2.1.2.3 CWS density point optimisation	UPM																																				
B2.1.2.4 CWS final point data integration	UPM																																				
B2.2 Vulnerability indicators	MOBICS, UPM, MoP																																				
B2.2.1 Vulnerability data selection, download and integration	MOBICS, UPM, MoP																																				
B2.3 Exposure indicators data download	MOBICS, UPM, MoP																																				
B2.3.1 Exposure indicators data download & integration	MOBICS, UPM, MoP																																				
C. Operation Activities																																					
C1. Urban Heat Risk Assessment	UPM, MOBICS																																				
C1.1 Hazard Assessment	UPM																																				
C1.1.1 Reference heat map	UPM																																				
C1.1.2 Preliminar CDD/HDD data	UPM																																				
C1.1.2.1 Urban climate severity (CDD/HDD) preliminary - points	UPM																																				
C1.1.2.2 Urban climate severity (CDD/HDD) preliminary - interpolation	UPM																	•																			
C1.1.2.3 Preliminary Urban Climate Zones definition	UPM																	•																			
C1.1.3 Modelling	UPM																																				
C1.1.3.1 Formatting ERA5; CWS data	UPM																																				
C1.1.3.2 Search for optimal structure of the models	UPM																																				
C1.1.3.3 Model training	UPM																																				
C1.1.3.4 Model testing	UPM																																				
C1.1.3.5 Generation of time series	UPM																																				
C1.1.4 Reference Year (RY)	UPM																																				
C1.1.4.1 RY extraction from the time series	UPM																																				
C1.1.4.2 Urban climate severity (CDD/HDD) - points	UPM																																				
C1.1.4.3 Urban climate severity (CDD/HDD) - interpolation	UPM																																				
C1.1.4.4 Urban Climate Zones (UCZ) definition	UPM																										•										
C1.1.4.5 Link between UCZ & RY	UPM																																				
C1.1.4.6 UWEC generation	UPM																											•									
C1.1.4.7 UWEC testing	UPM																																				
C1.1.5 Hazard Hotspots	UPM																																				
C1.1.5.1 Preliminary delimitation of hotspots in GIS	UPM																	•																			
C1.1.5.2 Delimitation of hotspots in GIS	UPM																											•									

WP4 Relevant Milestones (MS)
Relevant Technology Releases (TRs)
Other Contractual Milestones / Deliverables

- ≠≠≠≠ Deleted
- Not fullfilled
- New scheduling
- • Significant milestone (with description)
- To define

Table 31(SE4, Pilot 3) Gantt Chart progress. Pre-Pilot phase (cont.)



4.3 Service 5

4.3.0 Pilot 4

4.3.0.1 Testbed Scenarios

The Testbed Scenarios define the different case studies and possible scenarios. They provide the necessary information to understand who will be the service provider, the pilot, the objective, the necessary sources or inputs, the procedure to be followed and the outputs.

Scenario 5.1

Table 32. Operation testing for the for the (SE5, Pilot 4) case.

Scenario ID	S5.1
Developer	IMZI, NAZKA
Pilot	Ljubljana, Slovenia [IMZI]
Related Use Cases	UC5.1
Objective	The objective of this scenario is to test the flood damage assessment tool in a full pilot area and examine its functionality on defined inputs, actions, and expected outcomes. Functionalities: calculation of flood damage per building; visualization of flood damage through tables, graphs, and maps; selection of different flood scenarios.
Location	Ljubljana urban region, Slovenia, Extent: 45°56'26.83"S : 14°30'16.89"V.
Scale Scope	Urban region including residential and other buildings Area: 2334 km^2, Number of buildings: 204669.
Data	Geolocated information (building footprint), Buildings' geometry (boundary, area), Buildings' height, Buildings' use/typology, Buildings characteristics, Current and planned land use, Flood damage values (connection to building type), Flood extent scenarios, Digital Terrain Model.

Resources	QGIS, ArcMap 10.2.2.
Workflow	1. Create a geodatabase with the required data, 2. Implement the required data, 3. Analysis of building and land use data with ArcGIS, 4. Attribute damage values to buildings or land uses for the pilot area, 5. Create visualisations, 6. Evaluation of the results with Userback tool.
Additional Considerations	The testbed scenario should be repeatable so that it can be used to test different versions of the service.

4.3.0.2 Pre-Pilot Phase. Progress.

The Gantt Chart of Pilot 4 (Ljubljana Urban Region) for Service 5 has been modified in a few details. A subtask (C2.3.3.) has been added to testbed scenario S5.1 to make the responsibility clearer. A group of tasks has also been moved from group "C4. Pilot Results/KPIs Calculation & Assessment" to "C2. Operational testing" or "C3. Guidance with retrofitting instructions" as a new task with some subtasks or as a moved task - due to a more reasonable task organisation. Some new (updated) schedules have also been created according to new pre-pilot knowledge for B2.6, C2.4.2., C2.4.3. and C3.1. For C1.2.3 the schedule was added because the first version of the Gantt chart contained a slip. The reason for rescheduling C2.4.1. is that it has not yet been possible to obtain the national historical precipitation data. Actually, this data was not urgently needed for the pre-pilot phase, but we will start working on it in the short term to provide the necessary data for the full pilot phase.

During the pre-pilot phase, the IMZI, as pilot and service provider, has actively engaged with the technical partner NAZKA to identify, obtain and visualise the required data at city level for Use Case 5.1 Flood Damage Hotspots. Efforts are ongoing to finalise the visualisations.

IMZI has also started work to generate the climate scenarios and to produce a guide with retrofitting instructions. The first draft of these was used in the pre-pilot phase and work is continuing to provide the relevant one.

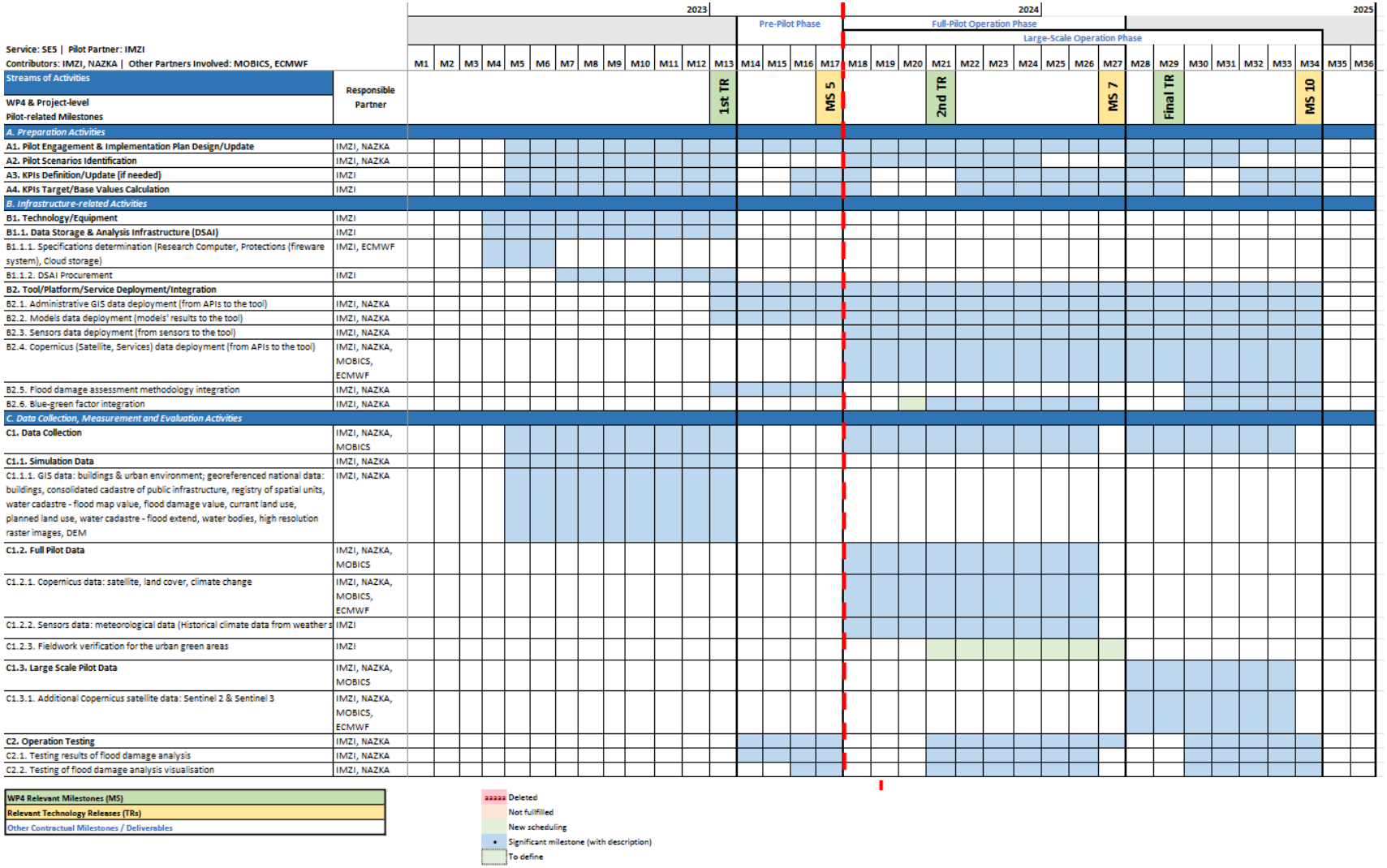
Table 33. (SE5, Pilot 4) Progress of tasks in the pre-pilot phase related to Gantt Chart

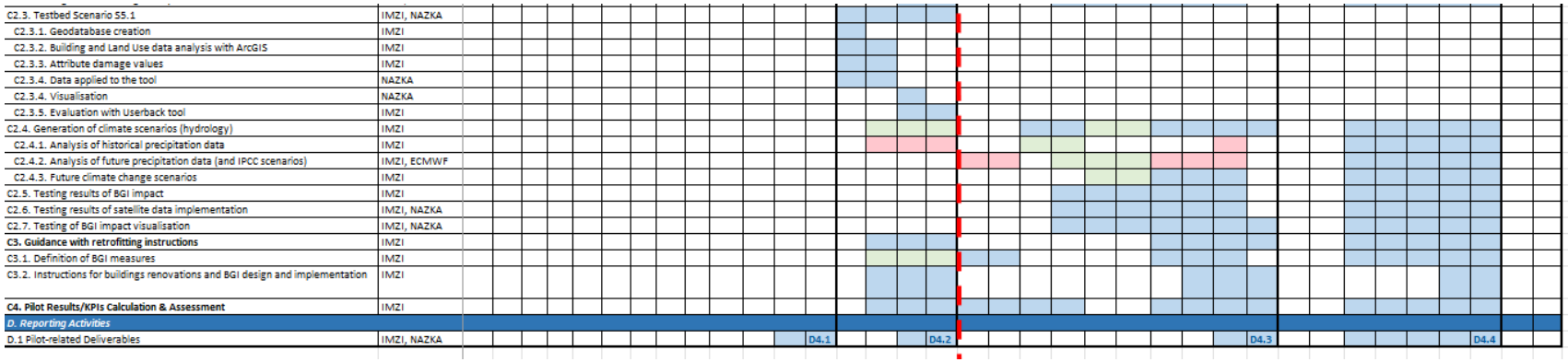
Responsible Partner	Streams of Activities	Month	Progress	Results
	B. Infrastructure-related Activities			
	B1. Technology/Equipment			

IMZI, ECMWF	B1.1.1. Specifications determination (Research Computer, Protections (fireware system), Cloud storage)	M5	Completed	specifications
IMZI	B1.1.2. DSAI Procurement	M7	Completed	computers, system
	B2. Tool/Platform/Service Deployment/Integration			
IMZI, NAZKA	B2.1. Administrative GIS data deployment (from APIs to the tool)	M13 - M34	In progress	7 datasets
IMZI, NAZKA	B2.2. Models data deployment (models' results to the tool)	M13 - M34	In progress	1 model results
IMZI, NAZKA	B2.3. Sensors data deployment (from sensors to the tool)	M18 - M34		
IMZI, NAZKA, MOBICS, ECMWF	B2.4. Copernicus (Satellite, Services) data deployment (from APIs to the tool)	M18 - M34		
IMZI, NAZKA	B2.5. Flood damage assessment methodology integration	M13	Completed	application
IMZI, NAZKA	B2.6. Blue-green factor integration	M20 - M26		
	C. Data Collection, Measurement and Evaluation Activities			
	C1. Data Collection			
	C1.1. Simulation Data			
IMZI, NAZKA	C1.1.1. GIS data: buildings & urban environment; georeferenced national data: buildings, consolidated cadastre of public infrastructure, registry of spatial units, water cadastre - flood map value, flood damage value, currant land use, planned land use, water cadastre - flood extend, water bodies, high resolution raster images, DEM	M13	Completed	10 datasets
	C1.2. Full Pilot Data			
IMZI, NAZKA, MOBICS, ECMWF	C1.2.1. Copernicus data: satellite, land cover, climate change	M18 - M26		
IMZI	C1.2.2. Sensors data: meteorological data (Historical climate data from weather stations)	M18 - M26		
IMZI	C1.2.3. Fieldwork verification for the urban green areas	M21 - M27		
	C1.3. Large Scale Pilot Data			
IMZI, NAZKA, MOBICS, ECMWF	C1.3.1. Additional Copernicus satellite data: Sentinel 2 & Sentinel 3	M28 - M33		

	C2. Operation Testing			
IMZI, NAZKA	C2.1. Testing results of flood damage analysis	M14	Completed	application
IMZI, NAZKA	C2.2. Testing of flood damage analysis visualisation	M16 - M34	In progress	application
	C2.3. Testbed Scenario S5.1			
IMZI	C2.3.1. Geodatabase creation	M13	Completed	1 geodatabase created
IMZI	C2.3.2. Building and Land Use data analysis with ArcGIS	M13	Completed	2 shapefiles created
IMZI	C2.3.3. Attribute damage values	M13	Completed	1 xlsx file
NAZKA	C2.3.4. Data applied to the tool	M14 - M17	In progress	application
NAZKA	C2.3.4. Visualisation	M15 - M17	In progress	coloured maps, graphs, tables, map slider
IMZI	C2.3.5. Evaluation with Userback tool	M16 - M17	In progress	application
IMZI	C2.4. Generation of climate scenarios (hydrology)			
IMZI	C2.4.1. Analysis of historical precipitation data	M20-M21; M30-M34	New Scheduling	
IMZI, ECMWF	C2.4.2. Analysis of future precipitation data (and IPCC scenarios)	M21-M23; M30-M34		
IMZI	C2.4.3. Future climate change scenarios	M22-M26; M30-M34		
IMZI	C2.5. Testing results of BGI impact	M21 - M26		
IMZI, NAZKA	C2.6. Testing results of satellite data implementation	M21 - M26		
IMZI, NAZKA	C2.7. Testing of BGI impact visualisation	M21 - M27		
IMZI	**C3. Guidance with retrofitting instructions**			
IMZI	C3.1. Definition of BGI measures	M15-M19; M24-26; M30-M34	In progress	1st rough draft
IMZI	C3.2. Instructions for buildings renovations and BGI design and implementation	M15-M17; M25-27; M33-M34	In progress	1st rough draft

Table 34. (SE5, Pilot 4) Gantt Chart progress. Pre-Pilot phase




C2.3. Testbed Scenario S5.1 IMZI, NAZKA
C2.3.1. Geodatabase creation IMZI
C2.3.2. Building and Land Use data analysis with ArcGIS IMZI
C2.3.3. Attribute damage values IMZI
C2.3.4. Data applied to the tool NAZKA
C2.3.4. Visualisation NAZKA
C2.3.5. Evaluation with Userback tool IMZI
C2.4. Generation of climate scenarios (hydrology) IMZI
C2.4.1. Analysis of historical precipitation data IMZI
C2.4.2. Analysis of future precipitation data (and IPCC scenarios) IMZI, ECMWF
C2.4.3. Future climate change scenarios IMZI
C2.5. Testing results of BGI impact IMZI
C2.6. Testing results of satellite data implementation IMZI, NAZKA
C2.7. Testing of BGI impact visualisation IMZI, NAZKA
C3. Guidance with retrofitting instructions IMZI
C3.1. Definition of BGI measures IMZI
C3.2. Instructions for buildings renovations and BGI design and implementation IMZI
C4. Pilot Results/KPIs Calculation & Assessment IMZI
D. Reporting Activities
D.1 Pilot-related Deliverables IMZI, NAZKA
D4.1
D4.2
D4.3
D4.4
WP4 Relevant Milestones (MS)
Relevant Technology Releases (TRs)
Other Contractual Milestones / Deliverables
Deleted
Not fullfilled
New scheduling
Significant milestone (with description)
To define

5 BUILSPACE Monitoring. Stakeholders Engagement and Social Acceptance (T4.4)

In this section, we describe in detail the initial steps taken as part of Task 4.4. This holds significant importance as it focuses on stakeholder engagement and social acceptance, crucial elements for the success of the platform and the services and the project's sustainability. The objective of this task is not only the engagement on the services of different stakeholders, but also the initial connection with future users. This task is composed of 3 subtasks: Engagement of stakeholders on the use of the services, specific awareness for users, and a set of training materials.

For drawing a sustainable strategy, the task will focus on the activities of pilots and the services and provide a suitable roadmap on the engagement of the stakeholders. Therefore, ALDA will work closely with pilot and services partners to create a joint strategy to maximize BUILDSPACE's outreach efficiently.

It was decided that the engagement of stakeholders will have two dimensions: European and Local Level,

- European Level: The communication and future engagement of stakeholders at a European level will be centralized in the project website and social media through the communication of the project progress and activities that may be of interest for different stakeholders.
- Local Level: The engagement of stakeholders at a local level will be mainly managed by the pilot partners with the support of the service partners and ALDA, which will consider the current stakeholder engagement and will create a joint strategy for enhancing the local stakeholders' collaboration.

The baseline for the stakeholder engagement is the results of D2.1. and D2.2. focused on the target groups of BUILDSPACE and the target groups per service, respectively. They are detailed as follows:

Table 35. Identified target groups during the user story elicitation process and a brief description for each of them.

Target Group	Brief Description
Citizens, tenants, and owners	Citizens and individual owners
Facility managers	Managers that oversee the management of a facility's physical assets
SMEs, companies, and entities	Small and Medium enterprises that deal with sustainability issues of buildings and cities

Policy makers	Public authorities and policy makers (e.g., municipalities)
Utilities	Public and private utilities
Constructors and contractors	Construction companies and engineering consultancy firms
Investors	Real estate investors

Taken from D2.1.

Table 36. Identified target groups per Service.

Services	Brief Description
Service 1 and 2	Facility managers Construction companies and designers
Service 3	Urban stakeholders (urban planners, the real estate sector and policy makers) Citizens and homeowners
Service 4	The general public (citizens) Advanced users (academia, public administration, public sector) Super users (pilot)
Service 5	Urban planners and policy makers Citizens, buildings owners and tenants.

Taken from D2.2. - User flow definitions

As part of the baseline for the stakeholders at a local level, we have considered the participants of both co-creation sessions foreseen in WP2 who previously showed an interest in the services and the project. The focus is on the participants based on the countries of each pilot.

For stakeholders at a European level, all BUILDSPACE partners will suggest European bodies, networks and organizations that might be interested in the pilot implementation or project activities to raise awareness about the services and pilots.

The roadmap for creating a joint strategy of stakeholder engagement is detailed in the following sections

5.1 Engagement of stakeholders on the use of the services

Engaging stakeholders entails actively involving building users and city stakeholders in utilizing BUILDSPACE services. This engagement considers the diverse roles within the project as outlined in D2.1. and mentioned in the previous section.

The main strategy for stakeholder engagement at the local level is co-designed by the pilots and service partners, given their experience in the place of implementation. However, ALDA will provide some guidelines or suggestions on how to involve them. On the other hand, the strategy for the stakeholder at a European level will follow the same guidelines with the main difference that the point of contact will be the project. The goal is to maximize the engagement of diverse stakeholders in the different project activities.

The strategy is defined as follows, and it will the peculiarities of each pilot will be considered accordingly:

5.1.0 Stakeholder Mapping

ALDA shared with the pilots and the services an excel document to track stakeholders in the territories of implementation, as well as to map the stakeholders at a European Level.
The stakeholder mapping aims to understand the interests and motivations of the organizations in their relationship with BUILDSPACE and to gain more information on the stakeholders that can support our activities' capitalization. Initially, the stakeholders who attended the co-creation sessions have been included in the map as a baseline, and more stakeholders will be added according to the progress of the pilots.

In a first stance, it has been considered the categorization of these stakeholders into one of the seven types of stakeholders identified in D1.2., a contact in the organization, the interests as well as previous connection with the project (e.g. participation in the co-creation sessions), the BUILDSPACE pilot or service who can get in touch with the stakeholder and the level of engagement foreseen.

The level of engagement encompasses five levels: **low-level involvement (Be Informed, Collaborate**) which primarily focuses on communication, while **high-level involvement** (**Be Consulted, Be Involved, Empower**) emphasizes active stakeholder participation. Low-level engagements serve as initial steps, laying the groundwork for more structured relationships between stakeholders and the pilots. Meanwhile, high-level engagements facilitate deeper knowledge exchange and effective co-creation processes. It is relevant to identify these levels to understand the current state of the pilots and their possibilities for engagement.

Combining various levels of engagement is key to effectiveness, with informing stakeholders being vital even at higher levels. These levels offer flexibility, allowing stakeholders to choose activities based on their preferences and needs.

It is important to note that the engagement levels are not mutually inclusive; for instance, the "Empower level" does not automatically encompass activities from the "Collaborate level." This approach is designed for flexibility, enabling stakeholders to be part of the activities that align with their goals and interests. Pilot and service partners should consider the country context when determining the most appropriate engagement approach.

5.1.1 Design of the process and active engagement

ALDA will organize a session at the end of M16 (May 2024) with all the pilots and services. During this session and with the collaboration of the pilots and services partners, feedback on the following roadmap involves:

- Goal setting: Considering the needs and motivations of the stakeholders mapped, the pilots will define the goals for the stakeholder engagement according to their context.
- Tailor messaging: Understanding the types of stakeholders predominantly in each pilot will allow the creation of specific materials of each stakeholder. (See 7.3 for more information) This will mainly emphasize how BUILDPSPACE can help them achieve their specific goals.
- Education and Training: The definition of the types of stakeholders in each pilot will facilitate the creation of comprehensive training sessions and resources to familiarize stakeholders with BUILDSPACE services and functionalities. This will be defined with the pilot partners according to the needs of each territory.
- Incentives and Rewards: It is important to encourage active participation of the BUILDSPACE services, so the strategy will adapt to the foreseen activities of each pilot to understand the possibilities of each service. The common strategy for all stakeholders will be to invite them to be part of the BUILDSPACE community.
- User Experience Enhancement: The stakeholder engagement will encourage continuous communication with stakeholders. In these communications, feedback will be gathered to identify the areas of improvement to enhance the user experience and ensure that BUILDPSPACE meets the evolving needs of its stakeholders.
- Community Engagement: The project will foster a sense of community among BUILDPSPACE users by facilitating networking opportunities, knowledge sharing forums, and collaborative initiatives. It is highly encouraged that stakeholders share success BUILDSPACE stories, best practices, and lessons learned.
- Monitoring and Evaluation: The pilot partners will evaluate continuously how the stakeholder engagement is evolving over time and identify areas of success and areas for improvement. If needed, the strategy must be adjusted to meet their needs.
- Iterative Improvement: ALDA will meet with the pilot partners to refine the engagement strategy, which will remain flexible and adaptive to evolving stakeholder needs and pilots' progress.

5.2 Training programmes

The task involves implementing specific awareness and training programs tailored to the target groups. These programs aim to motivate users by highlighting the tangible benefits of BUILDSPACE services and providing comprehensive explanations of their operation, both from a system and methodological standpoint.

To support this, a set of training materials including presentations, brochures, and notes will be developed as will be mentioned in the following section 7.3. This will be done according to the needs of each pilot. The specific training will be defined in the part of Education and Training in cooperation with the pilot partners in the strategy's design, as mentioned in the previous section.

The project aims to capitalize all the outcomes of the project; therefore, the project will consider the outcomes of *T6.4. Training for university students* as part of the Training programmes available for stakeholder engagement. The goal of these materials is to provide additional and specific information on how to use the services of BUILDSPACE.

5.3 Materials

Engaging stakeholders directly is crucial for gaining acceptance and promoting the use of BUILDSPACE services in the community. Task 4.4 plays a vital role by providing stakeholders with the knowledge and motivation they need, contributing significantly to the project's success and sustainability over the long term.

The materials available for all partners include mainly the outcomes of WP6, T6.2 which will be released periodically according to the project's progress. The materials include 10 infographics, 9 project factsheets, 4 trial videos, and 5 episodes of a technical podcast.

They will be available on the project's website and encouraged for the partners to share it with their stakeholders to enhance their communication. These materials will be further explained in D6.3., expected to be ready by M18 (July 2024).

As mentioned in 7.1.2, depending on the needs of the pilots, more specific materials will be created for supporting their implementation.

6 BUILDSPACE Monitoring. Assessment from economic, social, and environmental perspective (T4.5)

6.1 Key Performance Indicators

6.1.0 Services Specific KPIs

In this section, we describe the KPIs reflecting the services' specific features and will be measured at the end of pilot operation phases. In particular, for each service, at least three specific KPIs have been defined, the responsible for the KPI, the percentage of the KPI developed or achieved and additional comments, as described in D4.1 (Table 3).

Table 37. List of services' specific KPIs.

KPI ID	Title	Description	Service					Unit	Target	Responsible	State of the target	% Achieved	Comments
			SE1	SE2	SE3	SE4	SE5						
KPI 1	Percentage of Envelope Constructed	The envelop area of DT model compared to the point cloud collection area. The collected point cloud data might be of low-quality in some areas due to the bad lighting situation or the inclusion of the surrounding buildings or objects.	•					%	90% per façade/roof of the collected data of the building	UOC	The service is going to evaluate 4 different scenarios and at the pre-pilot phase they just tested 1 of them, so the state of target is 1/4.	25%	The developed method in the pre-pilot stage can be used in the following three pilot cases in the following work.
				•						UPM	The service is going to evaluate 4 different scenarios (RGB and thermal for each pilot) and at the pre-pilot phase they just tested 1 of them, so the state of target is 1/4.	25%	Information has only been obtained from one of the pilots, with RGB information.
KPI 2	Surface Point Cloud Noise[1]	Similarity between real surface and point cloud surface.	•	•				mm	[10, 50]	UPM, UOC	0/2	0%	The final point clouds have not yet been obtained, so it has not yet been possible to evaluate this KPI. The model is currently being tested.
KPI 3	Level of Detail	The Level of Detail of the constructed geometric DT.	•	•				LOD	LOD1.2 – LOD 3.3[2]	UOC, UPM	The service is going to evaluate 4 different scenarios and at the pre-pilot phase they just tested 1 of them, so the state of target is 1/4.	25%	The developed method in the pre-pilot stage can be used in the following three pilot cases in the following work.
KPI 4	IPCC Scenarios	The number of IPCC scenarios considered.			•			#	3	CARTIF	The service is going to evaluate 3 different scenarios, but they will be implemented within the second and third	0%	

KPI ID	Title	Description	Service					Unit	Target	Responsible	State of the target	% Achieved	Comments
			SE1	SE2	SE3	SE4	SE5						
											technology release, so at the moment it is not implemented yet.		
						•				UPM	0	0%	For the pre-pilot phase it's going to work only with the current climate. The implementation of future scenarios is envisaged for the end of the Full-Pilot phase.
							•			IMZI	The service is going to consider 3 different IPCC scenarios, but in the pre-pilot phase they didn't use any of them, so the state of target is 0/3.	0%	In the pre-pilot stage, the development was going on the Use case 1 which don't apply IPCC scenarios. IPCC scenarios are outside the scope of the pre-pilot phase based on Testbed Scenario S5.1.
KPI 5	Retrofitting Scenarios	The number of retrofitting scenarios generated. Retrofitting measures and strategies will be developed and the user will be able to choose one or more to apply and compare.			•			#	3	CARTIF	This functionality will be deployed for the third technology release, so it is not achieved yet (only internal work has started).	0%	
							•			IMZI	The service is going to generate 3 retrofitting scenarios and in the pre-pilot phase they just tested 1 of them, so the state of target is 1/3.	33%	The developed method in the pre-pilot stage can be used in the following three pilot cases in the following work.

KPI ID	Title	Description	Service					Unit	Target	Responsible	State of the target	% Achieved	Comments
			SE1	SE2	SE3	SE4	SE5						
KPI 6	Solar Radiation Accuracy	Accuracy estimation of the usable solar radiation of suitable rooftops.			•			%	85	NTUA			
KPI 7	Cost Reduction	% of cost reduction in the energy bill for buildings.			•			%	5 Y1, 8 Y2, 15 Y3	NTUA, CARTIF	The KPI is calculated for available buildings in cadastral no 58 of the first technological release. For future releases it will be calculated for all avalaible buildings in the city of Riga (scaling).	31.5% [3]	The cost reduction relies on PV potential and estimated actual energy consumption of the available buildings. For the 1st technological release we estimated the energy demand of buildings, and calculated the PV potential. The same method developed in the pre-pilot stage can be applied on the buildings that will be examined in the context of the remaining two pilot phases.
KPI 8	Emissions Reduction	% of carbon emissions reductions due to energy efficiency and energy consumption services.			•			%	3-5 Y1, 8-10 Y2, 12-15 Y3	NTUA, CARTIF	The KPI is calculated for available buildings in cadastral no 58 of the first technological release. For future releases it will be calculated for all avalaible buildings in the city of Riga (scaling).	2.98% [4]	The emission reduction relies on PV potential and estimated actual energy consumption of the available buildings, as well as the emission profile of power generation in Latvia. For the 1st technological release we estimated the energy demand of buildings, and

KPI ID	Title	Description	Service					Unit	Target	Responsible	State of the target	% Achieved	Comments
			SE1	SE2	SE3	SE4	SE5						
													calculated the PV potential. The same method developed in the pre-pilot stage can be applied on the buildings that will be examined in the context of the remaining two pilot phases.
KPI 9	Urban Climate Zones	Ability to generate Urban Climate Zones (UCZs) according to the city's climate features.				•		Binary	Yes	UPM	0%	0%	According to the SE4 Gantt chart, the generation of the UCZ will take place during the Full-Pilot phase.
KPI 10	Map Data Resolution	Achieved resolution of the generated maps.				•		m	100	UPM	50%	50%	Several proxy indicators are being tested, mainly by trying to find equivalences from Copernicus to some Landsat datasets that are more widely deployed.
							•			IMZI	The service is going to generate map with data resolution up to 100 m and in the pre-pilot phase they achieved this resolution.	100%	The developed method in the pre-pilot stage can be used in the following three pilot cases in the following work.

[1] Surface noise refers to the deviation of the scanned surface from a perfect plane. To calculate this deviation, the distance of each point of the captured surface with respect to the perfect plane is calculated, which must be less than 50mm. To measure this KPI in the pilots, all planar surfaces

such as façades or roofs will be detected and compared with a perfect plane in order to get the maximum, minimum and average deviation of each.

[2] The value depends on the data quality, the purpose, and the construction (Biljecki et al. (2016)).

[3,4] KPIs 7 and 8 were calculated where energy demand was available and with the assumption that energy demand is similar or same with energy consumption. It will be re-calculated for the next releases with the energy consumption calculation (taking into account the energy source) for selected buildings.

6.1.1 General KPIs

In this section, we describe the set of KPIs defined for the evaluation of general dimensions of the BUILDSPACE system, reflecting platform effectiveness, user satisfaction, or entailing “horizontal” application to all services, as described in D4.1 (Table 4)

Table 38. List of general KPIs

KPI ID	Title	Description	Dimension	Unit	Target	Responsible	State of the target	% Achieved	Comments
KPI 11	Data Diversity	Number of distinct data types accessed. The aim is to ensure that the platform facilitates access to an adequate number of datasets types.	Platform, Data	#	10	**SLG**	5	50%	During the testing of the core platform, we have used 5 distinct data types (jpeg, JSON, binary, png, pdf). This will be extended in the context of the pilot testing.
KPI 12	Open Source Resources	The number of open-source resources integrated in BUILDSPACE solutions.	Platform, Services	#	Platform: 6; SE1: 3; SE2: 1; SE3: 2; SE4: 4; SE5: 10	**UOC, UPM, CARTIF, IMZI**	SE1: 1/3; SE2: 3/5 SE3:4/2 SE4: 2/4; SE5:7/10	SE1: 30%; SE2: 60%; SE3: 150%; SE4: 50%; SE5: 70%	**SE2:** CloudCompare, ImageJ, own software **SE3:** open data integrated in the SE3 so far (first technological release) are OSM, TABULA/EPISCOPE and PVGIS. **SE4:** Copernicus Climate Change Service, Copernicus Land Service **SE5:** Buildings, Registry of spatial units, Flood damage value, Current land use, Planned land use, Water cadastre-flood extend, Water cadastre - Flood map value
KPI 13	User Requirements	In-scope user requirements that addressed, based on outcomes of Deliverable D2.2.	Services	#	30	**ALDA**	24/30	80%	Beyond D2.2, the measurement is also based on the outcomes of the 3rd update of the User Requirements,

									which has been included as a dedicated section in D2.3.
KPI 14	Copernicus Integration Accuracy	Percentage of successful data integrations from Copernicus APIs	Platform, Data	%	90	**SLG**	90%	100%	During the testing of the Copernicus API, we have measured the successful data requests, and the results show a success rate at least 90% as anticipated.
KPI 15	Copernicus Data Diversity	Number of distinct Copernicus datasets accessed through the BUILDSPACE platform	Data	#	12	**SLG**	350	>100%	Copernicus API provides access to all datasets from Climate change and Atmosphere services. For the Land Service, a manual process is followed due to the specific nature of the Land Service API.
KPI 16	Usability	Evaluation of the ease of use of the BUILDSPACE services	Services	%	70	**ALDA**	0	0%	The ease of use will be evaluated after the stakeholders use the services in the implementation period of each pilot
KPI 17	Social Acceptance of BUILDSPACE Services by Engaged End-Users	Measure the likelihood of users to recommend a service to others (Net Promoter Score).	Services	%	30 Y1, 56 Y2, 90 Y3	**ALDA**	0	0%	The Net Promoter Score will be evaluated after the stakeholders use the services in the implementation period of each pilot
KPI 18	Data Accessibility	Number of pilots' datasets accessible by the intelligent quering	Data	#	3 Y1, 6 Y2, 10 Y3	**SLG**	0	0%	This is moved to the second phase of the core platform testing with the pilots

KPI 19	Diversification	Number of countries without a space tradition where BUILDSPACE services tested	Services	#	4	**SLG**	0	0%	This KPI will be updates after the completion of the services testing in the 4 pilots.
KPI 20	Value Recognition	Number of stakeholders/organizations recognizing business value on BUILDSPACE solutions	Platform, Services	#	20 Y1, 40 Y2, 80 Y3	**SLG**	65	162.5	65 participants 2nd co-creation workshop

7 Conclusions and Next Steps

This document reflects the monitoring and evaluation process of the deployment of all services in their pilots, the stakeholder's engagement and the impact of the project.
Progress has been made both at the building level and the city level and no bottlenecks or barriers are foreseen in the next steps in the full pilot operation. All services are being implemented in their corresponding pilot and an adequate impact can be foreseen.

7.1 Building Level

Development of the services 1 and 2 has progressed significantly during the Pre-Pilot phase. All Pilots were engaged in cooperation with technical partners and the management team. All concerns and questions were dealt with on an immediate issue. Any changes to the Gantt Chart were discussed with partners engaged during four T4.2 coordination meetings as well as during cameral meetings between each Pilot and their Service provider. Despite deviations in a few activities, no risks to the development of solutions were identified.

Next steps

During the upcoming Full-Pilot phase, building-level Pilots will continue their work according to the Gantt charts. Coordination meetings will continue to play their role in monitoring the status of solution development, sharing information and discussing any issues that arise.

7.2 City Level

Despite difficulties obtaining datasets needed, service development is on track and keeps set timelines. Cooperation between service developers, pilots and management team is on a high level. Every technical issue is discussed and settled. Each step of service development is continuously monitored. There are no significant deviations from implementation plans of services.

Next steps

According to the developed monitoring procedure all the service development partners continue to provide progress information in accordance with the implementation timetable. A monthly technical meeting will be held to exchange an actual information on development progress.
Preparations are underway for pre-pilot stakeholder involvement for each pilot to test the existing development, attract local stakeholder attention and integration of possible improvements.

7.3 Stakeholders

In conclusion, T4.4 aims to contribute to the success and sustainability of the BUILSPACE platform by effectively engaging stakeholders and social acceptance. Through a comprehensive strategy involving both European and local levels, ALDA and its partners will lay out a clear roadmap for engaging diverse stakeholders. This strategy includes mapping stakeholders, tailoring messaging, providing education and

training, and fostering continuous communication to enhance user experience. The dual approach ensures that stakeholders at both levels are informed, collaborate, consulted, involved, and empowered depending on the pilots' approaches, thus creating a solid foundation for widespread adoption and support of the BUILSPACE services.

This task also foresees the iterative improvement and adaptation towards meeting stakeholders' evolving needs. There will be a provision of diverse training materials, including presentations, brochures, infographics, factsheets, trial videos, and technical podcasts, highlighting a robust framework for ongoing engagement. By incorporating feedback mechanisms, the strategy remains flexible and responsive. This adaptability is crucial for addressing the unique contexts of each pilot and maintaining the relevance and effectiveness of the engagement efforts.

The stakeholder engagement strategy will be elaborated together with the pilot's needs during an online session that aims to define the goals, target stakeholders and upcoming activities per pilot. This session's input will be standardized in a set of guidelines delivered to pilots on how to engage stakeholders at a local level. These guidelines will consider a common strategy for all pilots with an emphasis on the particularities of some territories.

7.4 Key Performance Indicators

The results obtained in this pre-pilot phase shows a level of fulfillment adequate given the state of the service deployment in the pilots.

General Key Performance indicators related to the use of Copernicus datasets and integration via API are completed. Also, it can be highlighted that those related to usability are still to be achieved as the services will be fully deployed in the full pilot phase and in that moment they will be able to assess and complete.

The service related KPIs show progresses in the development of the project and in the services. The lack of fulfillment of KPIs has been explained, and main cause is that the KPIs target do not apply at this stage of the pre-pilot.

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