Project Acronym:	**VICINITY**
Project Full Title:	**Open virtual neighbourhood network to connect intelligent buildings and smart objects**
Grant Agreement:	**688467**
Project Duration:	**48 months (01/01/2016 - 31/12/2019)**

Deliverable D5.3

VICINITY value-added services deployment, validation, upgrade and evaluation

Work Package:	**WP5 – Value-Added Services Implementation**
Task(s):	**T5.3 Continuous operation and upgrades of value-added services**
Lead Beneficiary:	**CERTH**
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14.	Enercoutim – Associação Empresarial de Energia Solar de Alcoutim	ENERC	Portugal
15.	Municipality of Pilea-Hortiatis	MPH	Greece

[1] ***Deliverable Type:***
R: Document, report (excluding the periodic and final reports)
DEM: Demonstrator, pilot, prototype, plan designs
DEC: Websites, patents filing, press & media actions, videos, etc.
OTHER: Software, technical diagram, etc.

[2] ***Dissemination level:***
PU: Public, fully open, e.g. web
CO: Confidential, restricted under conditions set out in Model Grant Agreement
CI: Classified, information as referred to in Commission Decision 2001/844/EC.

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Executive Summary

The deliverable D5.3 – Value-Added services deployment, validation, upgrade and evaluation, is a report on the realisation, upgrades, refinements and updates of the implemented use cases and Value-Added services of each pilot site, that were performed during T5.3. It is a continuation of the previously submitted work in deliverables D5.1 [1] and D5.2 [2]. This deliverable presents the agile development of the Value-Added services and User Interfaces per pilot site, based on the evaluation on both technical and business perspectives (WP8) and the actual installation and deployment of the IoT infrastructure (WP7).

Improvements on the offered services, were implemented following the feedback that pilot sites have received during the Value-Added services operation in real-life conditions. The pilot sites had to overcome several challenges concerning business and technical aspects, like the user acceptance of the services and the fast prototyping and integration of new functionalities and improvements. Through this iterative process, upgraded versions of the offered services and solutions as well as new services were implemented and added to the VICINITY Platform. The use cases have also evolved a lot, even further from the initial expectations, thanks to the valuable new insights from the stakeholders and the continuous software development work of the pilot sites teams.

The work of this task was very important for the development of mature IoT services, that are re-usable and IoT vendor agnostic, since they are communicating with the IoT devices in a well-defined, interoperable way through the VICINITY platform. The implemented updates add even more value to the VICINITY Platform, which apart from the interoperability as a service, offers also an IoT service registry that serves as an IoT Marketplace.

In this deliverable, the methodology that was followed for providing continuous updates on the Value-Added services as well as the User Interfaces, is presented together with the methodology for this deliverable's reporting procedure. In the next paragraphs, each pilot site has presented the corrective and perfective maintenance activities that it performed in order to cover new or changed user requirements and/or fix any issues, so as to provide an enhanced version of the offered services to the end-users. Moreover, new Value-Added services and User Interfaces that were implemented to address new user requirements or as a proof of concept of VICINITY functionalities are also presented. The templates that were used for reporting this work in a uniform way are placed as an Annex.

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List of Definitions & Abbreviations

Abbreviation	Definition
CO2	Carbon dioxide
DoA	Description of Action
EU	European Union
GDPR	General Data Protection Regulation
IEQ	Indoor Environmental Quality
IoT	Internet of Things
MS	Milestone
O&M	Operation & Maintenance
PV	Photovoltaic
SIM	Subscriber Identity Module
SMS	Short Message Service
UC	Use Case
UI	User Interface
UV	Ultraviolet
UX	User Experience
VAS	Value-Added Service
VPS	Virtual Private Server
WP	Work Package

1. Introduction

1.1. Context within VICINITY

[1] Figure 1-1 gives an overview of the context of D5.3 within VICINITY. D5.3 reports the updates concerning the implementation of the VASs and UIs defined in D5.1 and D5.2 that were made available after achieving MS6, which made available the first version of VICINITY Value-Added services. The objective, as described in the Grant Agreement [GRANT AGREEMENT NUMBER — 688467 — VICINITY, H2020-ICT-2015/H2020-ICT-2015

[2] https://datarob.com/essentials-software-development-life-cycle/

[3] https://www.tpssoft.com/service/maintenance-support

], was to gather feedback on both the technical performance and user experience and to make improvements to the services. Feedback was gathered from members of the VICINITY Advisory board, end users and service providers and this assisted in performing updates, refinements, upgrades and enhancements, which are presented in the rest of the document.

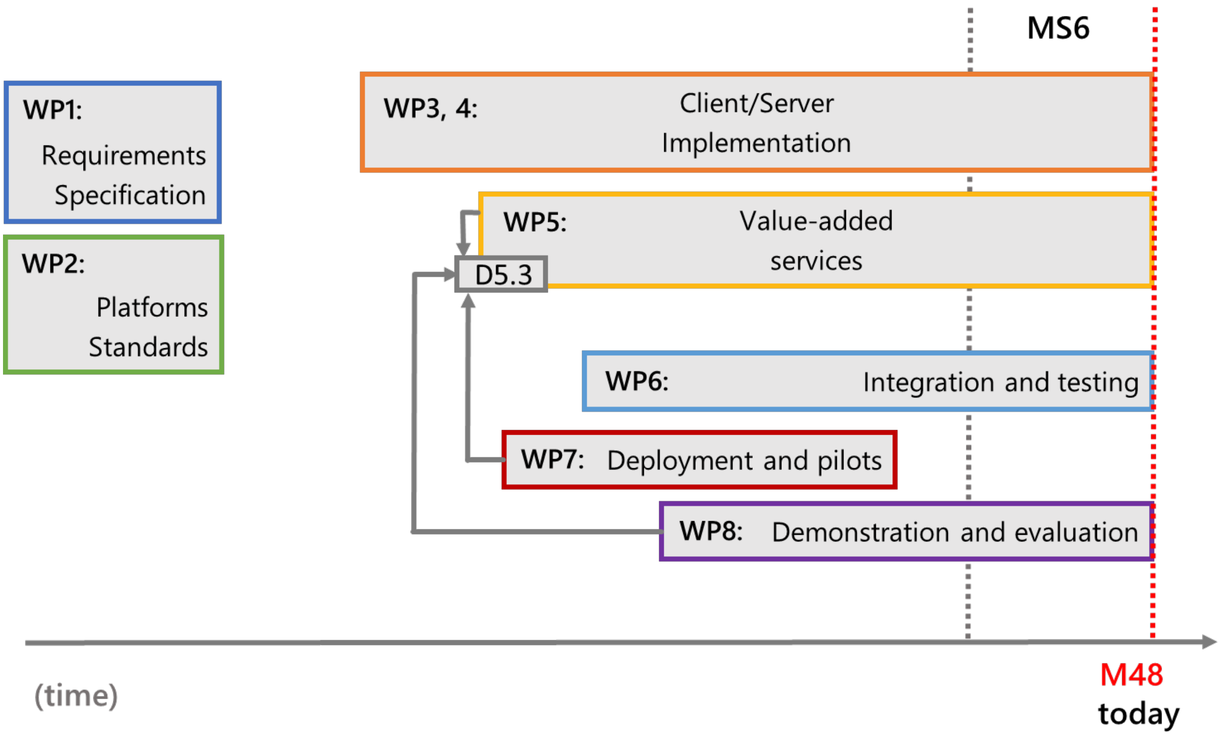


Figure 1-1 Context of D5.3 within VICINITY

Regarding the relation to other deliverables, the current document builds on the results of previous deliverables, specifically:

- **D5.1:** Value-added services definition requirements and architectural design (M24)
- **D5.2:** Value-added services implementation framework (M33)
- **D7.2-D7.5:** Report on each Pilot's Use Cases installation (M39)
- **D8.2-8.5:** Pilot results for each Use Case (M45)

The final milestones for the project are reached in Month 48. These include the *MS9 Pilot demonstration and overall system evaluation*, which is achieved after demonstrating one year of continuous operation of the pilot sites, which were thoroughly evaluated in terms of technical, functional and business aspects. T5.3 and T8.6 (Overall Evaluation) worked closely together for this purpose, throughout the final year of the project. The overall evaluation is reported in D8.6 *Evaluation of user experience and performance of VICINITY Framework & value-added services*.

1.2. Objectives in Work Package 5 and Task 5.3

The deliverable analyses the updates and continuous operation activities of T5.3, as a continuation of D5.2 and D5.1. It focuses on a technical overview of the offered solutions for each use case and on the updates of requirements, functionalities and corrective maintenance actions implemented by each pilot site for the Value-Added services (VAS) and the corresponding user interfaces.

D5.1 described the use cases and the VASs of the four pilot sites, their role and purpose as well as their requirements, taking into account VICINITY Platform requirements, specification and architecture, as well as identified barriers (WP1). VASs take as input IoT data from the infrastructures that are part of the VICINITY network and processes them in order to extract useful services for the end users, while D5.2 gives a detailed overview of the implemented VASs.

Feedback from stakeholders and end-users was assessed (WP8) and assisted in performing necessary updates, after the initial deployment of the necessary IoT equipment (WP7). The assessment conducted in all the pilot sites, concerned both technical and user experience evaluation. Continuous operations and upgrades to the VASs and the user interfaces that were implemented by the pilot site partners during this period are further described in this document.

1.3. Structure of the Deliverable

The report contains 9 Chapters and 1 Annex. These include the deployments at the four pilot sites with the addition of smart parking and building management in the Ústi region which is additional to the activities described in the DoA. In particular:

- **Chapter 1**: Introduction to the deliverable regarding its scope, objectives and defining the related documents.
- **Chapter 2**: Methodology followed for the task and the document
- **Chapter 3:** Oslo Science Park (NO) – Buildings and Smart Transport
- **Chapter 4**: Tromsø (NO) – Neighbourhood Smart Parking Assisted Living eco-system
- **Chapter 5**: Martim Longo (PO) – Neighbourhood GRID ecosystem
- **Chapter 6:** Pilea-Hortiatis (GR) – eHealth & Assisted Living
- **Chapter 7:** Ústi region (CZ) – Ústi region proof of concept
- **Chapter 8:** Conclusions
- **Chapter 9**: References
- **ANNEX I**: Templates used

2. Methodology

The work reported in this deliverable refers to the continuous software development activities concerning the VICINITY VASs and UIs. The needs of the project, as well as the needs of the pilot sites require a development process that is adaptive to changes and modifications both in the environment and the user requirements. Thus, an agile methodology was followed during the entire process, in order to respond to the needs and deliver the desirable results. **Fehler! Verweisquelle konnte nicht gefunden werden.** depicts the basic activities of an agile software development lifecycle.

Figure 2-1 Agile Software development lifecycle [7]

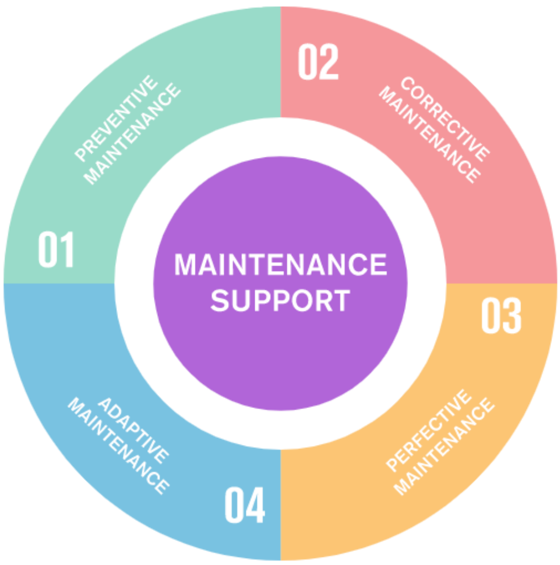


Figure 2-2 Software maintenance types [8]

Planning, Analysis and Design of the pilot site Use Cases and the VASs were performed in the course of T5.1 as illustrated in Figure 2-1, whereas Implementation, Testing and Integration were performed in the course of T5.2, T6.1 and T6.2. T5.3 and relate to the activities of Maintenance, which can be categorized into the four classes as shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**. These are:

- *Adaptive* – modifying the system to cope with changes in the software environment
- *Perfective* – implementing new or changed user requirements which concern functional enhancements to the software
- *Corrective* – diagnosing and fixing errors, possibly ones found by users
- *Preventive* – increasing software maintainability or reliability to prevent problems in the future

The maintenance work that was performed throughout this period on the VASs and UIs, mainly included perfective and corrective activities based on the users' feedback. Due to the close collaboration with the stakeholders, it was easy to track any errors that resulted in *Corrective* actions as well as any new or updated requirements that resulted in *Perfective* maintenance and the re-initiation of a new development cycle (Figure 2-1): *Planning* of the development work, the *Analysis* of the new requirements, the *Design* of the new functionalities, the *Implementation* of the code, the *Testing* of the new functionalities and re-deployment of the service.

Based on the way that the software development outcomes of T5.2 were reported in D5.2 [5] and the aforementioned analysis, we designed and adopted three templates to report the maintenance work that has been performed during this task on the VASs and UIs respectively. The templates can be found in Annex I - Templates. The templates provide a reference to the respective use case of the VAS/UI and allow the reporting of the performed *Corrective* and *Perfective* activities. For the latter, it was also important to mention the new or updated user requirements that led to the new functionalities, so this was added to the templates as well. As for the UIs, it was important to mention the work related to the users support, since this was a very important process for the adaptation of the implemented VASs and UIs to the daily life of the use-case participants, as well as to provide new screenshots of the UIs, showing the updated functionalities offered to the end-users. The relevant templates can be found in Annex I - Templates.

Apart from the software development activities, hardware maintenance activities have taken place during this period, following WP7 activities which are also reported in this document. Moreover, in some cases a new VAS has been implemented to cover new needs and these are also reported. During the period of T5.3, bi-weekly teleconference meetings have been organized by CERTH, in which participants from all pilot sites presented the ongoing work related to the pilot site activities, focusing mainly on the feedback they acquired from the end-users and the new functionalities of the VASs and UIs.

3. Oslo Pilot Site (NO) – Buildings (TINYM)

3.1. Use Case 1a.1 – Predictive operations

VAS 1a.1.1 interacts with interfaces 1a.1.1, 1a.1.2 and 1a.1.3, allowing users to track the number of visits since last cleaning, view history of cleanings and register rooms as cleaned. The use case has undergone significant upgrades, with the close cooperation of stakeholders, which allowed us to identify the need for two new VASs and several new features for the existing VAS 1a.1.1. These new features in VAS 1a.1.1 were requested by the stakeholders and addressed the specific needs they had. The new VASs – 1a.1.2 and 1a.1.3 were also implemented based on the feedback from stakeholders.

3.1.1. VICINITY Value-Added services

VAS 1a.1.1	**Cleaning and waste removal notification service and warning**
Related Use Case	UC 1a.1 – Predictive operations
Updates on user requirements	1. SMS Notifications are not needed 2. Graphs to add visualisation to the reports
Functionalities upgrades	**Supply reports' data to the UI (Requirement 1)** ○ Functionality: Returns all registered cleanings for the room, number of visits and the date time of the cleaning registration. ○ Endpoint: GET /adapter/clean-room/<room_id> **SMS Notifications were disabled (Requirement 2)**
Corrective maintenance	Bug fixing

New VASs

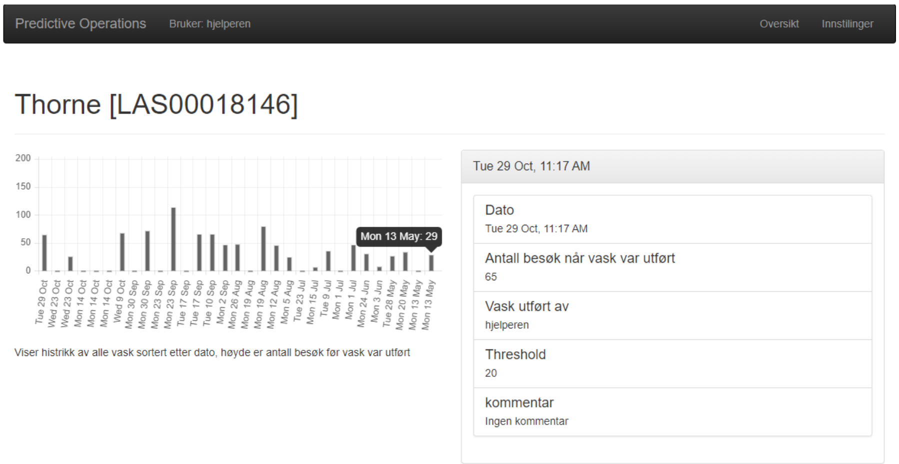
Two small VASs were developed – one for tracking CO2 levels in rooms and another for tracking number of visits to each room as detailed below.

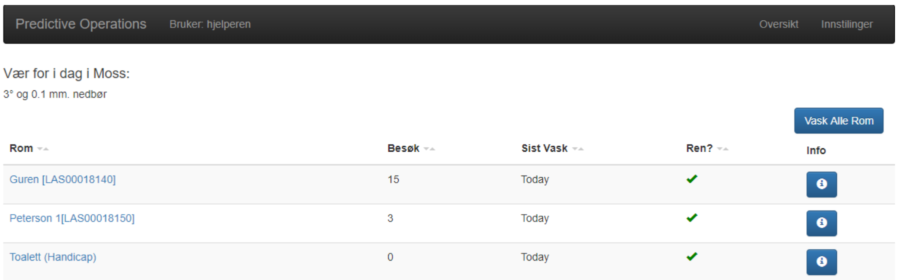
VAS 1a.1.2	**CO2 Monitoring VAS**
Related Use Case	UC 1a.1 – Predictive operations
User requirements	1. Collect data from CO2 sensors 2. Show graphs of the CO2 levels during the day 3. Show warning to the user if CO2 value reaches pre-defined threshold
Functionalities	**Receive CO2 Data from sensors (Requirement 1):** ○ Functionality**:** Receives CO2 measurements, from subscribed sensors. ○ Endpoint**:** PUT /objects/<subscriber_id>/publishers/<oid>/events/<eid> **Send CO2 Data to the front end (Requirement 2):** ○ Functionality**:** Returns CO2 levels measured during a given day defined by date. ○ Endpoint: GET /api/objects/<sensor_id>/date/<date> **Return if a warning exists (Requirement 3):** ○ Functionality**:** Return a Boolean value indicating if a CO2 level is above a threshold at the time of last received reading from the CO2 sensor. Treshold is fixed to 800ppm, but can be changed in the server configuration. ○ Endpoint**:** GET /api/objects/<sensor_id>/show-warning
Other	This VAS was developed based on the needs of the stakeholders to be able to monitor CO2 levels in rooms. There are 2 sensors, one is placed in the office of TINYM and another in one of the meeting rooms. Sensors are manufactured by VITIR. Sensors are not permanently attached and thus can be easily moved to a different room.

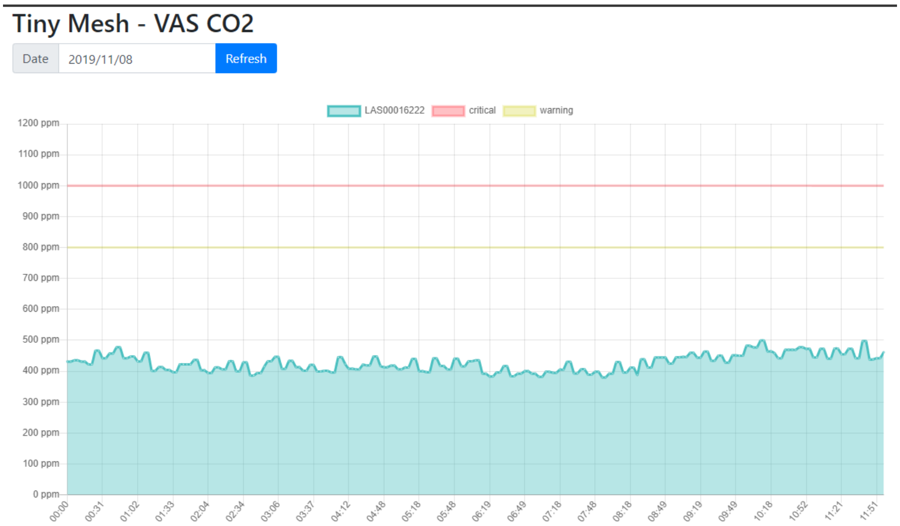
VAS 1a.1.3	Room Monitoring VAS
Related Use Case	UC 1a.1 – Predictive operations
User requirements	1. Collect data from door sensors 2. Aggregate data and calculate number of visits per room 3. Show overview over the visits to the user
Functionalities	**Receive door opening data from sensors (Requirement 1):** ○ Functionality: receives events from vicinity agent, based on the subscriptions defined in the configuration of the agent. ○ Endpoint: PUT /objects/<subscriber_id>/publishers/<oid>/events/<eid> **Return aggregated visit data for a given day (Requirement 2 and 3):** ○ Functionality: Returns number of visits to a room per hour, each registered door opening is rounded up to nearest half-hour and each opening and closing of the door is counted as 1 visit. Aggregation that happens here fulfils second requirement. ○ Endpoint: GET /api/objects/<door_id>/date/<date>
Other	This VAS was developed because stakeholders wanted a separate service to track room usage that would be separate from the main VAS that tracks both visits and cleanings. This will ensure that cleaning times remain available to only people who should have access to them, while giving access to the room visit data to more people.

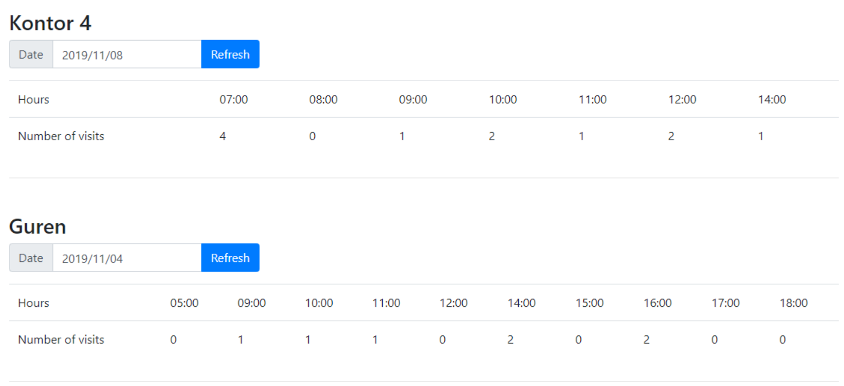
3.1.2. User Interfaces

UI 1a.1.1	Reports
Related Use Case	UC 1a.1 – Predictive operations
Updates on user requirements	-
Functionalities upgrades	-
Corrective maintenance	Bug fixes
User Support	Several meetings with stakeholders to gather feedback on usability of the application.

UI 1a.1.2	**Individual and statistical analysis of rooms**
Related Use Case	UC 1a.1 – Predictive operations
Updates on user requirements	1. Show a graph visualizing all cleaning performed
Functionalities upgrades	**Visualize cleaning reports** A graph was added to show at a glance a history of cleanings, visible only on desktop/tablets.
Corrective maintenance	Bug fixes
User Support	Several meetings with stakeholders to gather feedback on usability of the application.
Screenshots	 The screenshot demonstrates a graph of the performed cleanings and the number of visits to the room called "Thorne". The panel on the right shows detailed information about one single cleaning – date when cleaning was performed, number of visits since last cleaning, who cleaned and comments.

UI 1a.1.3	**Room usage and warnings**
Related Use Case	UC 1a.1 – Predictive operations
Updates on user requirements	-
Functionalities upgrades	○ Improved table showing all the rooms by adding ability to sort rooms by various parameters. ○ Ability to mark all rooms as cleaned at once. ○ Translated the page to Norwegian
Corrective maintenance	Bug fixes
User Support	Several meetings with stakeholders to gather feedback on usability of the application.
Screenshots	 The screenshot shows the main overview screen of the VAS, displaying the list of rooms in the building and the number of visits to each room as well as the time spent since the last cleaning. The checkmark indicates that the room doesn't need to be cleaned, in comparison to a red cross that would mean that the room needs cleaning.

UI 1a.1.4	**CO2 Monitoring**
Related Use Case	UC 1a.1 – Predictive operations
User requirements	1. Give an overview of the CO2 readings from sensors during the day 2. Show a warning when CO2 level reaches certain threshold
Functionality	**CO2 level graph (Requirement 1)** Show a graph to represent CO2 level during the day for each sensor connected **Show notifications (Requirement 2)** Show a warning when CO2 level reaches certain threshold
Corrective maintenance	-
User Support	-
Screenshots	 The screenshot shows a graph of the CO2 level in the room during the day.

<table>
<tr><th>UI 1a.1.4</th><th>Room Monitoring</th></tr>
<tr><td>Related Use Case</td><td>UC 1a.1 – Predictive operations</td></tr>
<tr><td>User requirements</td><td>1. Give an hourly overview of the number of visits to each room</td></tr>
<tr><td>Functionality</td><td>Show tables with the number of visits per hour based on the data from door sensors</td></tr>
<tr><td>Corrective maintenance</td><td>-</td></tr>
<tr><td>User Support</td><td>-</td></tr>
<tr><td>Screenshots</td><td>


The screenshot shows the number of visits to each room during the day. Visits are calculated on a per hour basis.</td></tr>
</table>

3.2. Use Case 1a.2 – Resource management

No changes to this use case since it was discontinued after a technical demonstration. Detailed reasoning for this is described in D8.3.

3.2.1. VICINITY Value-Added services

No changes have been made to the requirements or features of the VASs of this use case.

3.2.2. User Interfaces

No changes have been made to the requirements or features of the UIs of this use case.

4. Tromsø (NO) – Neighbourhood Smart Parking Assisted Living ecosystem (HITS)

Since HITS is not participating in T5.3, it has basically worked on the maintenance of the results produced in T5.2. This is therefore a brief summary of the ongoing activity in this Pilot, concerning the VASs and UIs, described in D5.2, and tested and evaluated in WP6 and WP8.

The VASs were developed for the use cases:

- 1b.1: Shared parking/priority parking
- 1b.2: eHealth Emergency parking

The differences between the two use cases are in how the trip is planned in advance and in the degree of flexibility that is offered when selecting user role and vehicle.

4.1. Pilot Use Case 1b.1: Shared parking/priority parking

The use case is based on the exchange of areas suitable for parking space. The exchange is normally based on first-come-first-serve requests; however, the priority parking option overrides the standard setting. Shared parking is one-way trip planning tool, although it supports the use of waypoints.

In the current version, information about the parking space being offered for rent is handled in the backend service. Next versions will handle also this, in the same mobile app that is used for booking/reservation.

4.1.1. VICINITY Value-Added services

No changes in VAS 1b.1.2 “Real-time operation”.

4.1.2. User Interfaces

No changes were implemented for UI 1b.1.1 “Administration of parking space” and UI 1b.1.2 “Real time Information about parking space”. During this period action was taken regarding user support e.g. phone support for technical issues.

4.2. Pilot Use Case 1b.2: eHealth Emergency parking

The use case has been renamed to Healthcare Visit / First responder parking since this is a more accurate description. The Healthcare Visit use case is based on a predefined round-trip, where travel time and assigning predictability is just as essential as identifying and reserving the optimal parking space. Emergency parking/First responder functionality is a subset of priority parking. In case that an alert is generated, the first to respond is immediately assigned a vacant parking space, overriding other reservations that already might have been in place for the parking space.

4.2.1. VICINITY Value-Added services

No changes were implemented for VAS 1b.2.1 “Residence data processing” and VAS 1b.2.2 “Smart parking event analysis”.

4.2.2. User Interfaces

No changes were implemented for UI 1b.2.1 “Administration of priority parking” and UI 1b.2.2 “Real time Information about priority parking in progress”. During this period action was taken regarding user support e.g. phone support for technical issues.

5. Martim Longo (PO) – Neighbourhood GRID ecosystem (ENERC)

User interfaces were substantially upgraded after the initial deployment, described in D5.2, as a result of the co-creation process with the stakeholders and the feedback collected from end-users. This process was continuous and as the possibilities to incorporate more data and sensors developed, functionality, reports and other approaches were also further developed.

The developments not only concerned the expansion of hardware or UI/UX, but also included additional features. The new features were developed to match emerging requirements, such as the request for improved visualization of specific parameters at the building level, the request for an overview of sensor inventory showing uptime and the number of alerts, warnings and anomalies detected.

The underlying data services of the VAS were also upgraded to incorporate semantic interoperability enhancements to the VICINITY platform and to improve historical data storage and retrieval.

A new inventory service that specifically allows for infrastructure monitoring was developed during this period.

The flexibility offered by the VICINITY platform allowed for new approaches to be considered and new services to be created, timely planned and implemented. Within the timeframes allocated.

Four main VASs and additional sub VASs were created addressing various functionalities on building level, IEQ, energy and resources consumption and the related systems inventory management, augmenting education processes as well as informational services on the local level. Flexibility and robustness of the VICINITY platform allowed for this rapid development leveraging the expertise of the team and co-creation with the stakeholders.

Heterogeneous topology of buildings in the Municipal Cluster allowed for the comparative performance of buildings and the performance of the related system through the implementation of a "light solution" that did not affect legacy systems and other components of existing infrastructures.

The replicability and relevance of this approach allowing for a high level of customisation depending on the building use and management requirements opened doors for additional pilot projects nationally and internationally.

Data produced and processed is relevant for decision making in near real-time as well for longer-term planning. Generated insights are suitable for additional analysis and reports, which constitutes an AI building block with potential to build analytics and further advisory services. Each typology of the buildings in the pilot can have a dedicated solution build in the future: Smart School, Retirement hope, Sports facilities management and solutions for residential buildings. The cluster of municipal buildings management now is possible and monitoring of compliance to the existing and planning for upcoming legislative compliance, for example, crass building electricity consumption per square meter of space. All the services implemented fit into the first two phases of the IoT Data marketplaces development stages as presented in AIOTI vision document: https://aioti.eu/wp-content/uploads/2019/09/AIOTI-Priorities-2019-2024-Digital.pdf adopted from the POV paper https://aioti.eu/wp-content/uploads/2019/02/IoT-data-market-places-drivers-and-architechtures-white-paper-Elloumi-De_Block-Samovicz.pdf

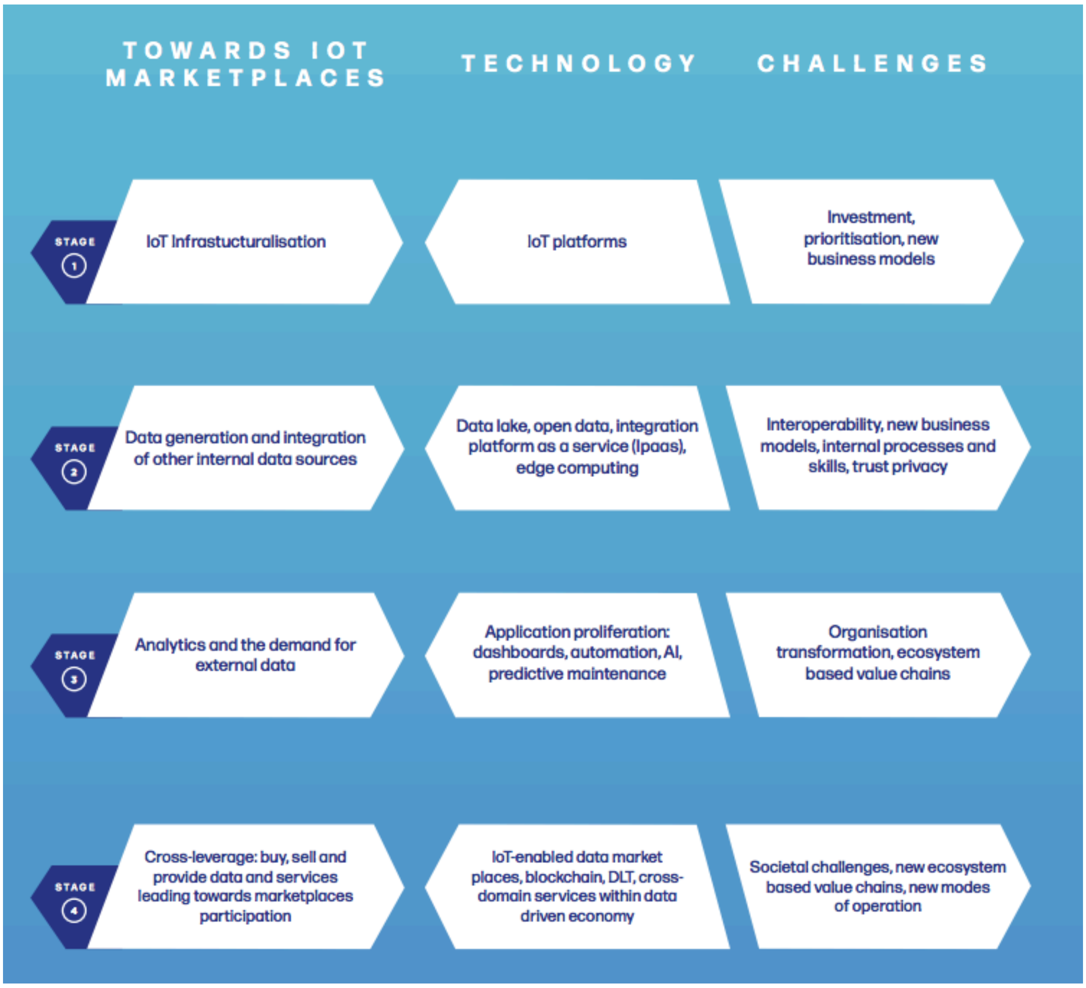


Figure 3 IoT data enabled Services Marketplaces[1]

Pilot site implementations and VASs correspond to the first three stages and allow for further developments to reach mode advanced stage.

5.1. Use Cases 2.1, 2.2, 2.3, 2.4, 2.5, 2.10, 2.11 – Energy Efficiency and IEQ Management in Municipal Cluster of buildings – Municipal Services

VAS 2.1 and related user interfaces apply to sub-Use Cases 2.1, 2.2, 2.3, 2.4, 2.5, 2.10 and 2.11 as described in D5.2. Dynamic Building Audit, Energy Demand Flexibility as a building block and Smart School, allows the users, the building manager on municipal level and local management and the maintenance operators to know at any time the current state of the indoor environmental quality (IEQ) of the building, resource consumption and usage of the facility. The historical data can also be accessed by the user, making it possible to visualize the evolution of the building conditions over time and identify changes in building conditions that might not be apparent by real- time monitoring. The IEQ parameters are compared to legal and optimal references letting the user know if their parameters fall within or outside of these boundaries.

Different types of sensor devices are used to collect real-time information from the buildings, specifically: temperature, CO_2, humidity, luminosity, noise, motion and energy consumption.

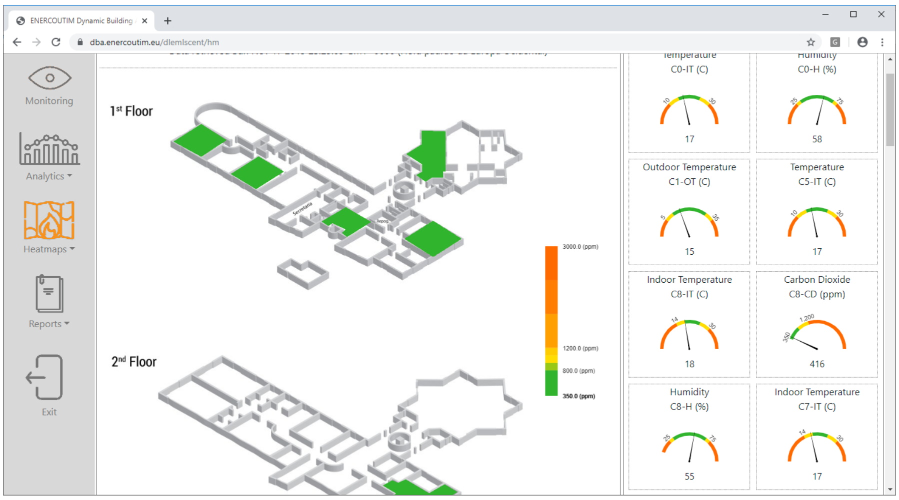
[1] : https://aioti.eu/wp-content/uploads/2019/09/AIOTI-Priorities-2019-2024-Digital.pdf

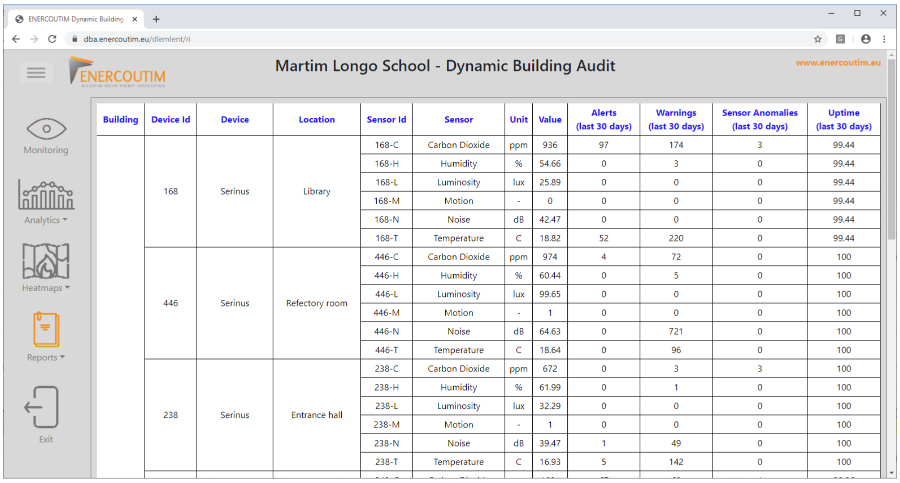
5.1.1. VICINITY Value-Added services

VAS 2.1	**Municipal Services, IEQ Smart School, Dynamic Audit**
Related Use Case	UC 2.1, 2.2, 2.3, 2.4, 2.5, 2.10,2.11
Updates on user requirements	No updates.
Functionalities upgrades	**Database for Historical sensor data** Historical sensor data storage originally relying on device specific historical data features was re-implemented at VAS layer to operate in a PostgreSQL database installed in the VAS server.
Corrective maintenance	o VAS was migrated from the Raspberry PIs where it was initially deployed to a standard x64 VPS in order to overcome inherent storage and performance limitations. o Minor real-time data and historical data retrieval issues were detected and fixed while implementing feature upgrades and were mainly related with programming errors (bugs).

5.1.2. User Interfaces

UI 2.1-2.5	Municipal Services, IEQ Smart School, Dynamic Audit
Related Use Case	UC 2.1, 2.2, 2.3, 2.4, 2.5, 2.10,2.11
Updates on user requirements	1. Improved visualization of optimal performance parameters at building level. **2.** Overview of sensor inventory showing uptime and the number of alerts, warnings and anomalies detected. Resulted in the VAS – IoT systems inventory management **3.** Incorporation of analytics for Electrical Load/Area
Functionalities upgrades	**Improved visualization (Requirement 1)** • Addition of icons and coloured circles to the device panels of the Monitoring diagram. • Addition of alert and warning thresholds to the Analytics 2h and Analytics 48h reports. • Addition of heat maps for visualization of parameters. • Dedicated heat maps for buildings in the clusters were developed. • Additional monitoring ratios for compliance on energy efficiency were introduced in the overview tables. • Additional recommended comfort boundaries were added to almost all the parameters to supplement the legal requirements boundaries. An extensive research was done to identify these boundaries. Each parameter now has two boundaries levels. **Sensor inventory (Requirement 2)** • Addition of Inventory and System Status report. **Incorporation of analytics for Electrical Load/Area (Requirement 3)** • Analytics for Electrical Load/Area in hourly ratio for the last 24h (Wh/m2) as a building block for compliance on annual bases (Y Wh/m2).
Corrective maintenance	Minor user interface issues were detected and fixed while implementing feature upgrades and were mainly related with browser compatibility and programming errors (bugs).

User Support	End-users were mainly supported through workshops, stakeholders meetings and onsite during the support and preventive maintenance interventions which occurred almost each month.
Screenshots	 Monitoring  Analytics 48h  Heatmaps



Building	Device Id	Device	Location	Sensor Id	Sensor	Unit	Value	Alerts (last 30 days)	Warnings (last 30 days)	Sensor Anomalies (last 30 days)	Uptime (last 30 days)
	168	Serinus	Library	168-C	Carbon Dioxide	ppm	936	97	174	3	99.44
				168-H	Humidity	%	54.66	0	3	0	99.44
				168-L	Luminosity	lux	25.89	0	0	0	99.44
				168-M	Motion	-	0	0	0	0	99.44
				168-N	Noise	dB	42.47	0	0	0	99.44
				168-T	Temperature	C	18.82	52	220	0	99.44
	446	Serinus	Refectory room	446-C	Carbon Dioxide	ppm	974	4	72	0	100
				446-H	Humidity	%	60.44	0	5	0	100
				446-L	Luminosity	lux	99.65	0	0	0	100
				446-M	Motion	-	1	0	0	0	100
				446-N	Noise	dB	64.63	0	721	0	100
				446-T	Temperature	C	18.64	0	96	0	100
	238	Serinus	Entrance hall	238-C	Carbon Dioxide	ppm	672	0	3	3	100
				238-H	Humidity	%	61.99	0	1	0	100
				238-L	Luminosity	lux	32.29	0	0	0	100
				238-M	Motion	-	1	0	0	0	100
				238-N	Noise	dB	39.47	1	49	0	100
				238-T	Temperature	C	16.93	5	142	0	100

Inventory and System Status

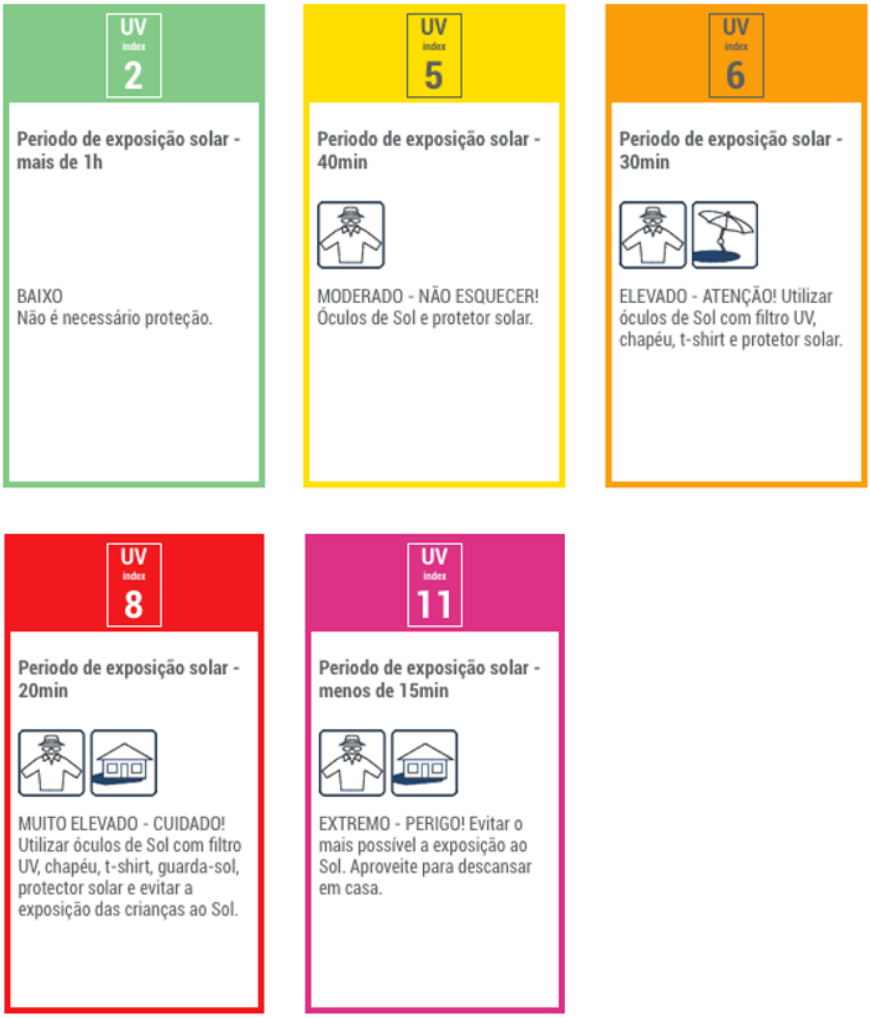
5.2. Use Case 2.9 – UV (Ultraviolet radiation) info services for Citizens and Tourists – Local to Local Services

VAS 2.2 and related user interfaces target Use Case 2.9. The service provides useful information to the students, senior citizens and citizens in general about the UV level advisory for behaviour (choices for time to spend outdoors, planning of outings and areas for outings, considering shading) and outdoor activities planning and additional alternative measures. The *UV for Citizens* VAS is also a model for equipment usage and leverage beyond primary function.

5.2.1. VICINITY Value-Added services

VAS 2.2	**Local to Local Services, UV for Citizens**
Related Use Case	UC 2.9
Updates on user requirements	1. Additional sources of information was considered to augment local readings
Functionalities upgrades	Integration of additional sources of information was considered. Need for external data from three areas related to climate change adaptation was identified and as a result there is a new VAS in development.
Corrective maintenance	None
Other	UV radiometer parametrization issues were detected and corrected, on the datalogger that collects radiometer measurements and converts data in UV index.

5.2.2. User Interfaces

UI 2.9	**Local to Local Services, UV for Citizens**
Related Use Case	UC 2.9
Updates on user requirements	No updates to system development. Service design was expended and external information sources were considered and integrated.
Functionalities upgrades	The iframe embeddable widget was enhanced to include recommendations identified and discussed with internal and external stakeholders
Corrective maintenance	Minor user interface issues were detected and fixed while implementing feature upgrades and were mainly related to browser compatibility and programming errors (bugs).
Screenshots	 Status of the UV widget for each level of UV risk.

5.3. Use Cases 2.6, 2.7 – Distributed Energy assets management – Platform Services

VAS 2.3 and related user interfaces apply to Use Cases 2.6 and 2.7. The scope of this VASs is to help the operation and maintenance manager of the PV production plant to plan cleaning of the photovoltaic modules to increase energy production, reduce costs and plan resource allocation and usage.

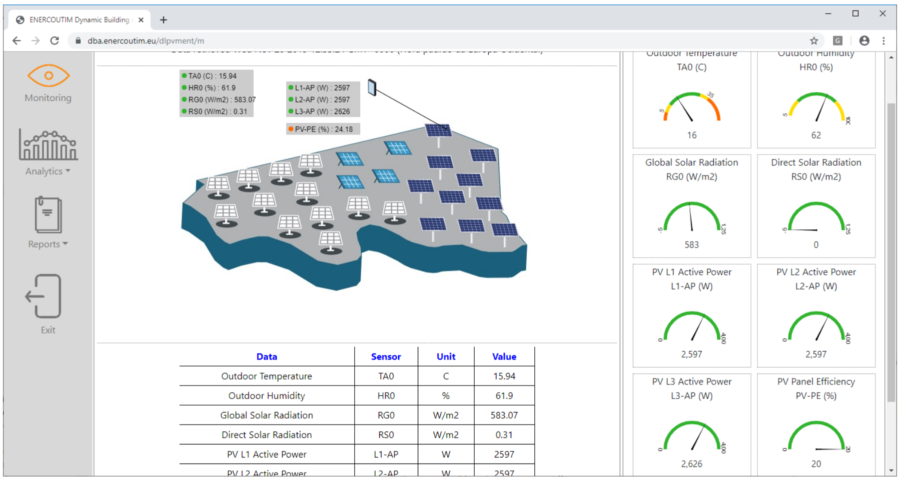
Distributed Energy asset management services compare actual PV production against available radiation measured with specific sensors installed at the SolarLab weather station, monitoring the effective PV panel efficiency ratio, and storing a comprehensive set of data (weather data, radiation and PV production) for further statistical and technical analysis.

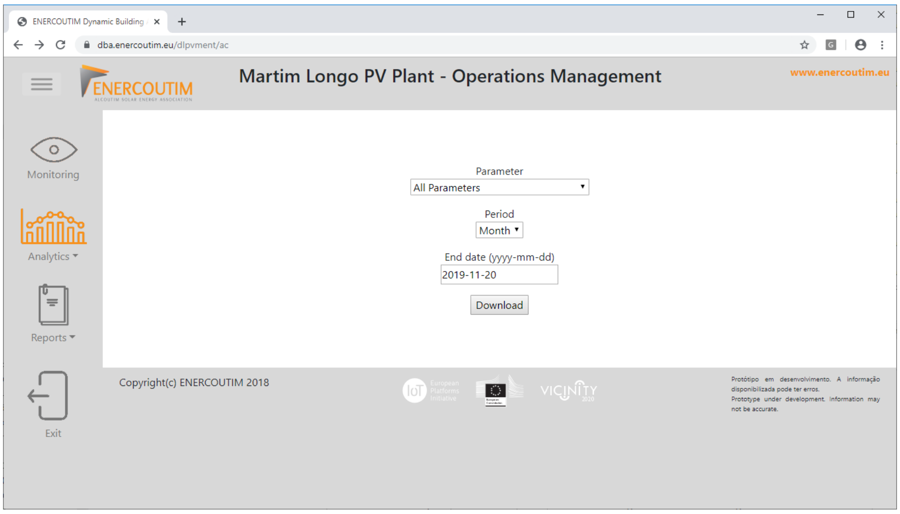
5.3.1. VICINITY Value-Added services

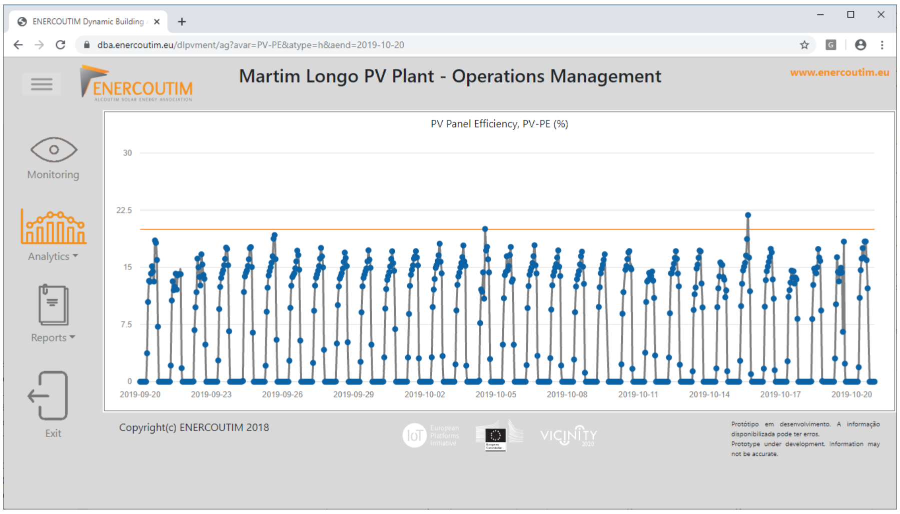
VAS 2.3	**Platform Services. Smart Clean. O&M for distributed renewable production resources.**
Related Use Case	UC 2.6, 2.7
Updates on user requirements	1. Climate services extension was discussed and incorporation of other external data on regional level is being planned, outlining the relevance of the service for further expansion. 2. Real-time computation of the PV panel efficiency
Functionalities upgrades	**Climate services concept extension and incorporation of external data (Requirement 1)** **Real-time computation of the PV panel efficiency was added (Requirement 2)**
Corrective maintenance	Minor real-time data and historical data retrieval issues were detected and fixed while implementing feature upgrades and were mainly related with programming errors (bugs).

5.3.2. User Interfaces

UI 2.6, 2.7	**Platform Services. Smart Clean. O&M for distributed renewable production resources.**
Related Use Case	UC 2.6, 2.7
Updates on user requirements	1. Export sensor data time-series to enable for analysis with external tools. **2.** Visualize sensor data time-series over specific periods.
Functionalities upgrades	**Export sensor data time-series (Requirement 1)** • Addition of an export and download feature of sensor data time-series for analysis with external tools. **Visualize sensor data time-series over specific periods (Requirement 2)** • Addition of a parametrizable time series graph.
Corrective maintenance	Minor user interface issues were detected and fixed while implementing feature upgrades and were mainly related to browser compatibility and programming errors (bugs).

<table>
<tr><td>User Support</td><td>End-users were mainly collaborators and were supported on request while performing PV maintenance planning and PV operation monitoring tasks.</td></tr>
<tr><td>Screenshots</td><td>


Monitoring diagram displaying sensor data and current PV panel efficiency.


Data download form


Parametrizable time-series graph
</td></tr>
</table>

6. Pilea-Hortiatis (GR) – eHealth & Assisted Living (CERTH – GNOMON – MPH)

The pilot site of Pilea-Hortiatis offers a number of eHealth services to its citizens, through VICINITY, that aim to improve their daily life. Its goal was to re-use and extend the existing infrastructure by adding value to the data from IoT devices and reshape it into meaningful information for the health professionals and the end users. Feedback by all stakeholders was acquired regarding the implemented VASs and UIs during T8.5, which allowed the software development team to improve and further extend the services to their needs. The final versions of the services have been also described and published for the IoT Catalogue [11], a European initiative that brings IoT users and technology providers together that promotes the concept of the IoT Data Marketplace.

6.1. Use Case 3.1 – eHealth and Assisted Living for elderly people at home

Use case 3.1 is focused on the elderly population of Pilea-Hortiatis. Assisted Living services have been implemented in T5.2 for supporting those who live alone. These services have been enhanced with new functionalities during T5.3 in order address new or changed user requirements and offer a better quality of service.

During the first period of operation of the pilot, bugs and errors occurred, so enhancements and fixes have been implemented respectively. A continuous research work for improving the abnormal behaviour detection algorithm of VAS 3.1.3 was performed, in order to offer more accurate and meaningful information to the health professionals, while new UI screens with explanatory graphs have been developed to support the new VAS's functionalities. Moreover, support to the end users was offered throughout the whole period.

6.1.1. VICINITY Value-Added services

VAS 3.1.1	**Privacy-preserving Data Gathering and Storage ft. GDPR data auditing**
Related Use Case	UC 3.1 – eHealth and Assisted Living for elderly people at home
Updates on user requirements	-
Functionalities upgrades	Functionalities are the same with the ones described in D5.2
Corrective maintenance	Bugs and errors occurred while monitoring auditing of data transaction and the data requests. Relevant correction were implemented by the pilot site responsible.

VAS 3.1.2	**Analysis and clustering of elderly's people medical data to detect unusual behavioural events**
Related Use Case	UC 3.1 – eHealth and Assisted Living for elderly people at home
Updates on user requirements	-
Functionalities upgrades	New functionalities were added in order to be aligned with the requirements that were set during M37-M42 for the first use case. **Get blood pressure statistics** ○ Functionality: The resource returns for each user: (a) the upper and lower systolic and diastolic blood pressure measurements for this person and the day that they occurred (b) the percentage of hypo, normal, hyper (stage 1), hyper (stage 2) and hyper crisis measurements from the total received measurements ○ Endpoint: PUT /objects/{oid}/properties/bloodpressure_stats **Get panic button statistics** ○ Functionality: The resource returns for each user: the number of events caused by i) pushing the base button, ii) pushing the wearable panic button iii) fall detection, as well as the total number of events. ○ Endpoint: PUT /objects/{oid}/properties/button_stats **Get weight statistics** ○ Functionality: The resource returns for each user: (a) the upper and lower weight measurements for this person and the day that they occurred as well as the total number of measurements. ○ Endpoint: PUT /objects/{oid}/properties/weight_stats
Corrective maintenance	Bug fixing and performance improvements

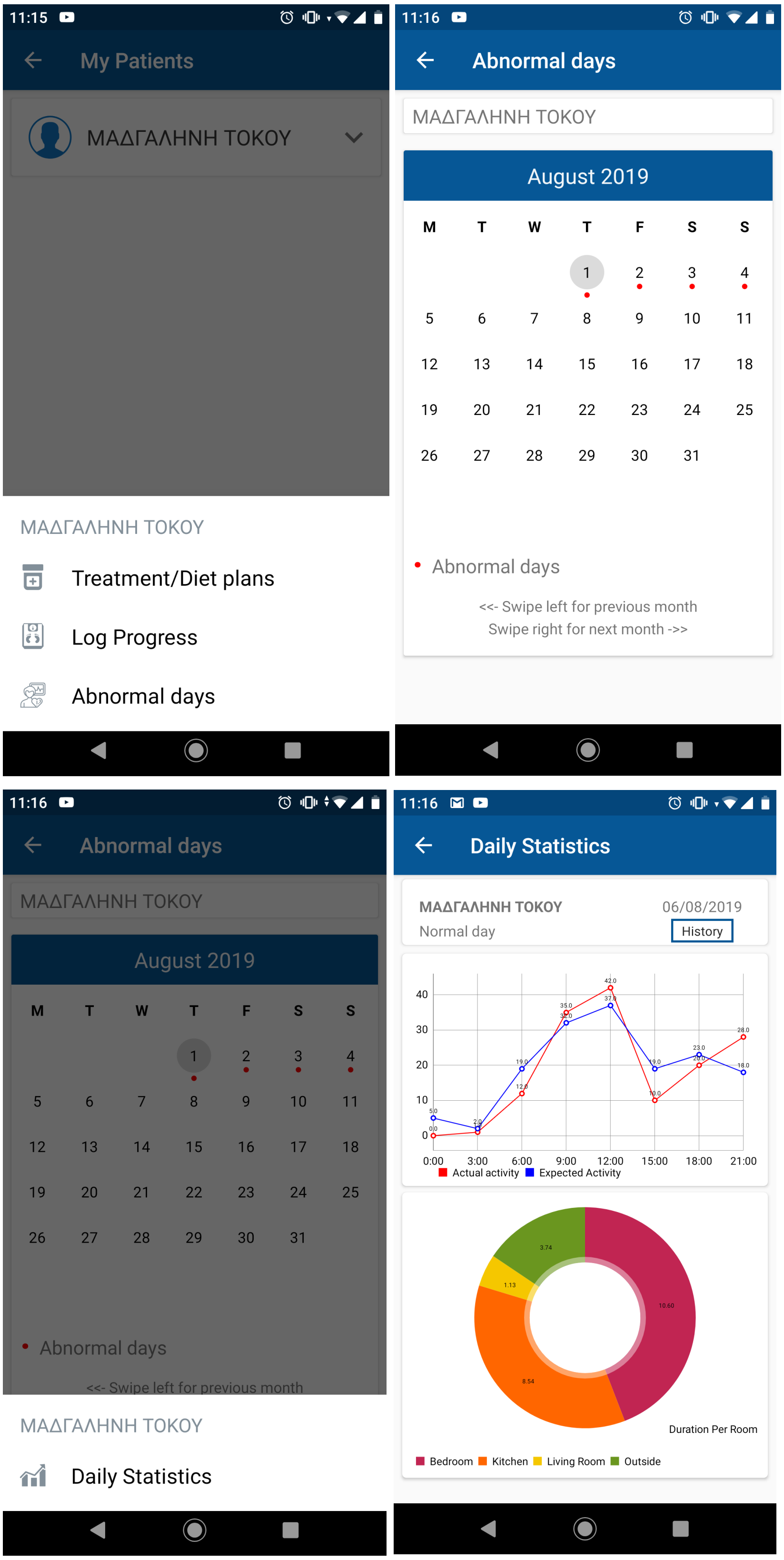
VAS 3.1.3	**Triggering abnormal detection in homes**
Related Use Case	UC 3.1 – eHealth and Assisted Living for elderly people at home
Updates on user requirements	During the first months of deployment, the following requirements arose: 1. **Increase the algorithm's accuracy and reduce false alarms**: During the first months of the realization we identified that detecting abnormal behaviour only for the spatial context, produced a number of false alarms for the health professionals, causing anxiety. The algorithm was able to detect behavioural changes in the usage of the spaces, which were quite often, thus they shouldn't raise an alarm. The need for generating more relevant notifications arose, as well as the following requirement. 2. **Display explainable content that help health professional** to interpret the algorithm's decision. This included the following: 2.1. Ability to sort patients according to the time and frequency of abnormal events 2.2. Ability to view the daily status of a patient for a month 2.3. Ability to view the past behaviour of a patient

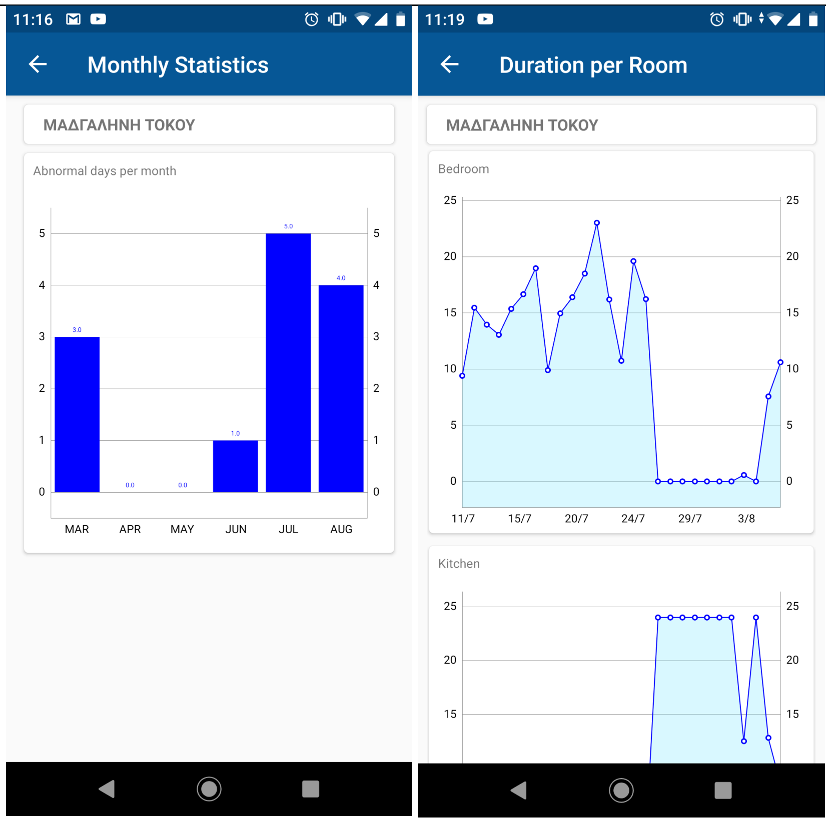
Functionalities upgrades	**Integrate a prediction-based model in the context of time complementary to the classification model (Requirement 1)** The approach for abnormal behaviour detection was revised, in order to detect abnormalities in the elderly person's behaviour in the context of both space and time. A prediction-based approach was implemented for the context of time and an evaluation was conducted to select the best machine-learning algorithm, in terms of accuracy and precision. This was applied to improve our approach. The temporal metric that was used is the activity level of the elder. The combination of the results of the classification and the prediction algorithm is used and a day is considered abnormal, only if the outcomes of both approaches agree, which produces a notification to the caregivers. This is an offline procedure. **Get sorting status (Requirement 2.1)** ○ Functionality: The resource returns the order of patients according to the time and frequency of abnormal events. The patients with the latest or more frequent events during the previous 30 days are sorted higher. ○ Endpoint: PUT /objects/{oid}/properties/sorting **Get abnormal dates for the past X days (Requirement 2.2)** ○ Functionality: The resource returns the abnormal dates for a patient for the previous X days from the input date. By default X=30. ○ Endpoint: PUT /objects/{oid}/properties/get_abnormal **Get abnormal days count for X previous months (Requirement 2.3)** ○ Functionality: The resource returns the abnormal days count for a patient for the previous X months from the input date. By default X=5. ○ Endpoint: PUT /objects/oid/properties/get_past_abnormal **Duration per room for previous month or last X days (Requirement 2.3)** ○ Functionality: The resource returns the daily duration spent in each of the house rooms and outside for the past X days. By default X=30. ○ Endpoint: PUT /objects/oid/properties/rooms_usage_duration_month or PUT /objects/{oid}/properties/rooms_usage_duration_30days **Get training data** ○ Functionality: The resource returns the training data that were used for the latest generated model. ○ Endpoint: PUT /objects/{oid}/properties/training_data_room

Corrective maintenance	**Update of models in a daily basis** Initially the classification models had been created with data from the first ninety days of tracking. This didn't allow us to leverage all dataset that we were continuously gathering every day. We decided to re-train the models every day, using data from all previous days that were considered as normal. **Bug fixes** Basically on the pre-processing calculations.
Other	This work was published in the context of *IEEE BIBE 2019 conference***Fehler! Verweisquelle konnte nicht gefunden werden.**

6.1.2. User Interfaces

UI 3.1.1 & UI 3.1.2	**Individual and clustering analysis of patients' medical history (for Health Care Professionals and Relatives)**
Related Use Case	UC 3.1 – eHealth and Assisted Living for elderly people at home
Updates on user requirements	Same as for VAS 3.1.3
Functionalities upgrades	**Calendar identifying Abnormal days** ○ Functionality: The health professional can track the abnormal days of an elder through his/her mobile application in a calendar view. **Elder's daily statistics** ○ Functionality: Daily information regarding the elderly person's behaviour in the house is collected. The time of day (normal/abnormal is given) and an explanatory graph is used to show actual activity compared to the expected activity produced from the model. Additionally, a donut graph is used to present the total hours spent in each room of the house. **Elder's monthly statistics** ○ Functionality: The number of days with abnormal activity for each month is presented in bar chart. **Time spent in each room for the last 30 days** ○ Functionality: Hours spent in each room for the last 30 days are presented in a consolidated diagram.
Corrective maintenance	Bug fixes
User Support	Regular visits of the health professionals to the elderly persons' homes and questionnaires for doctors' and relatives' provided feedback regarding the usability of the application so that improvements could be made.

Screenshots	



6.2. Use Case 3.2 – Health improvement for the middle-aged persons

Use case 3.2 has focused on the improvement of the fitness of the middle-aged citizens of Pilea-Hortiatis. Valuable feedback was acquired throughout the realization of the pilot and any bugs or errors that occurred were communicated to the development team which implemented the relevant fixes.

During the operation of the services in real-life conditions different mobile operating systems have been supported and updates to the internal rules of the gamification VAS were implemented according to the dietician's guidance. Moreover, several face-to-face meetings with the end-users have been conducted in order to offer user support on the use of the mobile application.

6.2.1. VICINITY Value-Added services

VAS 3.2.1	**Privacy-preserving Data Gathering and Storage ft. GDPR data auditing**
Related Use Case	UC 3.2 – Health improvement for the middle-aged persons
Updates on user requirements	-
Functionalities upgrades	Functionalities are the same with the ones described in D5.2
Corrective maintenance	• Bug fixing and errors occurred while monitoring and auditing of data transactions and the data requests

VAS 3.2.2	**Individual Statistical Analysis of data from wearables, medical devices, beacons**
Related Use Case	UC 3.2 – Health improvement for the middle-aged persons
Updates on user requirements	-
Functionalities upgrades	Functionalities are the same with the ones described in D5.2
Corrective maintenance	• Bug fixing was needed when communicating with the beacons, weight scales and the wearables for **Push Measurement** functionality because of different operating systems and releases in different Android mobile phones • Updates to the internal rules of the gamification system were needed depending on the dietician's guidance • Active feedback from end users through face-to-face meetings was needed in order to improve the performance of the application

VAS 3.2.3	**Aggregated Statistical Analysis of data from wearables, medical devices, beacons**
Related Use Case	UC 3.2 – Health improvement for the middle-aged persons
Updates on user requirements	-
Functionalities upgrades	Measuring the number of visits to the different athletic centres of the Municipality
Corrective maintenance	• Bug fixing • Updates in calls between services of the gamification system and the mobile application

6.2.2. User Interfaces

UI 3.2.1	**Individual and statistical analysis of patients' history (for Health Care Professionals)**
Related Use Case	UC 3.2 - Health improvement for the middle-aged persons
Updates on user requirements	-
Functionalities upgrades	Functionalities are the same with the ones described in D5.2
Corrective maintenance	Bug fixes and maintenance while being in frequent communication with the dietician
User Support	Questionnaires for dietician's feedback regarding the usability of the application in order to make improvements
Screenshots	Same as in D5.2

UI 3.2.2	**Tracking progress and bonus achieved (for citizens)**
Related Use Case	UC 3.2 - Health improvement for the middle-aged persons
Updates on user requirements	-
Functionalities upgrades	Functionalities are the same with the ones described in D5.2
Corrective maintenance	Bug fixes
User Support	• Meetings with users for supporting them with the usage of the application during their biweekly visits to the dietician • Action taken regarding user support e.g. phone support for technical issues • Questionnaires for users' feedback regarding the usability of the application in order to make improvements
Screenshots	Same as in D5.2

UI 3.2.3	Aggregated statistical analysis of municipality citizens progress (for Municipalities)
Related Use Case	UC 3.2 - Health improvement for the middle-aged persons
Updates on user requirements	-
Functionalities upgrades	Improve the look-and-feel of the dashboard
Corrective maintenance	Bug fixes
User Support	Questionnaires for Municipality feedback regarding the usability of the web interface
Screenshots	Same as in D5.2

6.3. Deployment Maintenance on site

The chapter gives an overview of the maintenance activities that have been performed in the pilot site's installations, following the T7.5 and the WP7 activities. The table below provides a brief summary of the actions that have been taken during the Post-Installation period, which was described in D7.1.

UC	Activities	Reason
UC 3.1	Battery replacement to motion and door sensors (8 houses)	Sensors stopped sending data
	Replacement of the routers' SIM cards in 24 houses	The service period of SIM cards has expired
	Replacement of fault/broken IoT equipment (2 houses)	The equipment stopped sending data.
	Re-deployment of IoT equipment to a different location (2 houses)	The elderly person has moved to a different location.
	Removal of IoT equipment (4 houses)	○ Moved to the son/ daughter's family ○ Passed away
	New installations of weight scales and blood pressure devices in 4 houses	Re-install equipment to new participants
UC 3.2	Visits to the Panorama athletic centre	Loss of the beacon that was deployed outdoors and deployment of a new one
	7 meetings with beneficiaries for active user feedback	Discussions about usability, improvements and bug fixes for the mobile application
	Meetings with the dietician	Discussion over issues with the beneficiaries (progress, engagement, interest)

7. Ústi region (CZ) – Ústi region proof of concept (BVR)

The VICINITY IoT platform was selected to participate as proof of concept for the IoT backbone for PORTABO[2] as common data platform for Usti Region. VICINITY is proving its concept in collaboration between public agencies, citizen and regional government currently in the domains of parking, building management and renewable energy community. Two VASs and the respective UIs have been implemented by BVR as a proof of concept of the functionalities that VICINITY platform is offering, concerning smart parking and smart building management in the city of Děčín.

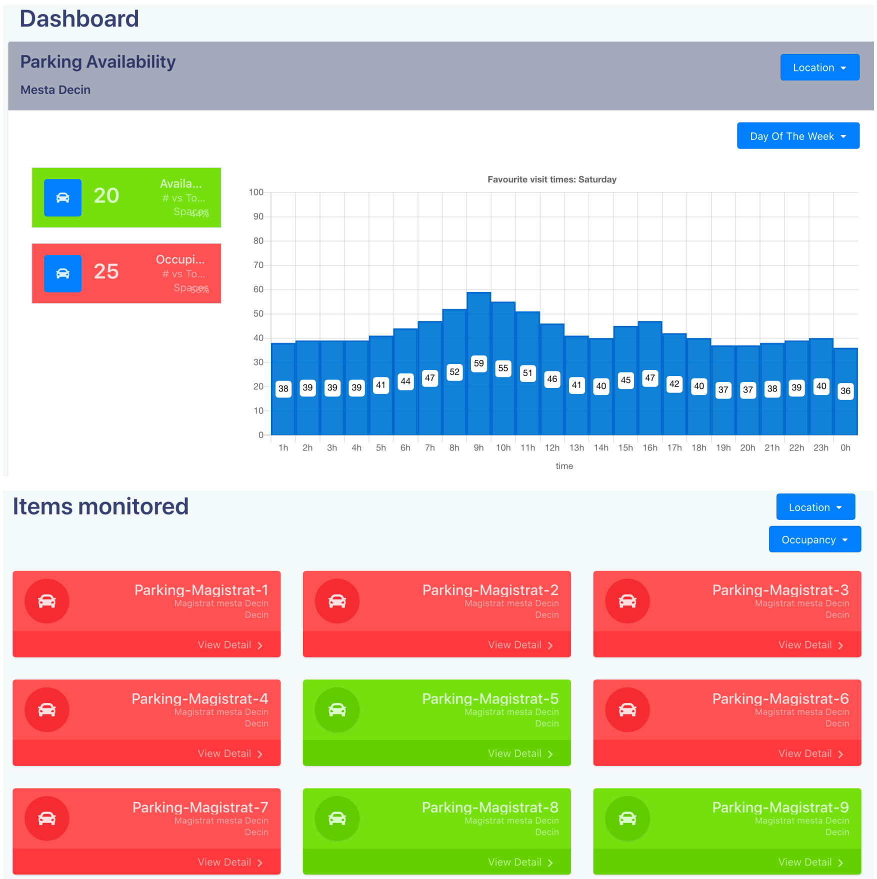
7.1. Smart parking in city of Děčín

7.1.1. VICINITY Value-Added services

VAS 7.1	**Monitoring the parking occupancy**
User requirements	-
Functionalities	**Collect real time parking occupancy** ○ Functionality: Reads real time state of each parking spot. ○ Endpoint: GET /api/objects/<object id>/properties/presence is sent from the VAS Gateway to the adapter Gateway. **Estimate occupancy based on history** ○ Functionality: Average occupancy for a given time and date. It makes use of the readings stored by the service. ○ Endpoint: POST /data with valid body is sent to the server that controls the persistence layer of the VAS.
Corrective maintenance	Bug fixing

[2] https://portabo.ujep.cz/

7.1.2. User Interfaces

UI 7.1	**Smart Parking monitoring application**
User requirements	-
Functionalities	- Reflect occupancy likelihood for a given day and time - Display occupancy per parking spot with colours. - Individual profile per parking spot.
Corrective maintenance	Bug fixes
User Support	Meetings with the stakeholders to gather feedback
Screenshots	

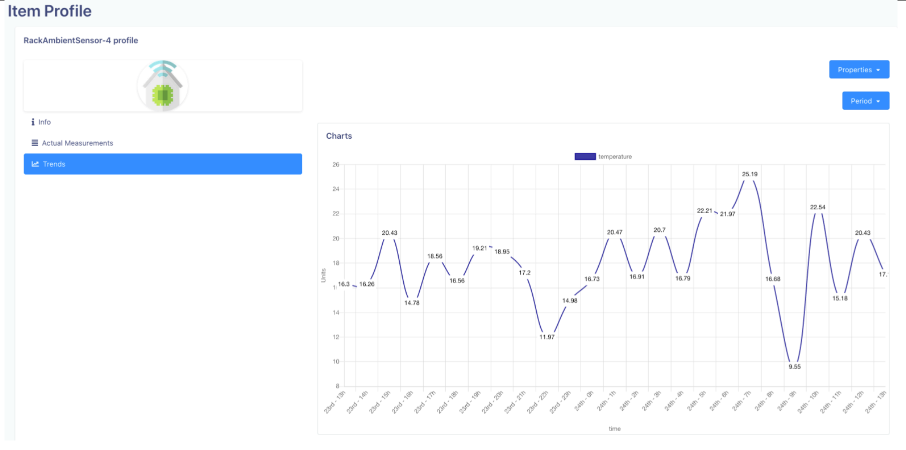
7.2. Smart building management in city of Děčín

7.2.1. VICINITY Value-Added services

VAS 7.2	Building sensor monitoring
User requirements	-
Functionalities	**Collect environmental sensor data.** ○ Functionality: Collect the data that is generated by the indoor sensors. The properties read are temperature, humidity, battery status and voltage level. ○ Endpoint: GET /api/objects/<object id>/properties/<sensor properties> is sent from the VAS Gateway to the adapter Gateway. **Collect current weather conditions.** ○ Functionality: Collect the data provided by the weather station. The properties read are temperature (avg, max and min), humidity, uvi, cloud coverage, pressure and wind (speed and orientation). ○ Endpoint: GET /api/objects/<object id>/properties/<sensor properties> is sent from the VAS Gateway to the adapter Gateway. **Generate charts and graphics based on data.** ○ Functionality: The VAS is able to generate different data aggregations that can be displayed by the UI. ○ Endpoint: POST /data with valid body is sent to the server that controls the VAS, the server will aggregate the requested values and send them back to the UI. **Check sensor status (Voltage level, low battery, offline …).** ○ Functionality: The VAS server checks the properties battery status and voltage level of each device. If there is some problem it will be displayed on the UI. ○ Endpoint: GET /items with valid parameters is sent to the server that controls the VAS.
Corrective maintenance	Bugs fixing

7.2.2. User Interfaces

UI 7.2	**Building sensor monitoring**
User requirements	-
Functionalities	- Display charts comparing different sensors data and weather conditions - Display item status with different colours - Display statistical distribution of sensors based on their different properties. - Individual profile for each sensor.
Corrective maintenance	Bug fixes
User Support	Meetings with the stakeholders to gather feedback
Screenshots	

Item Profile
RackAmbientSensor-4 profile
Info
Actual Measurements
Trends
Properties
Period
Charts
temperature
Units
time

8. Conclusions

This report presents the work of task T5.3, which concerns the operation, updates and enhancements of the implemented VASs and UIs. The work was a continuous agile process during which, changes in the maintenance phase initialized new software development cycles, in order to offer adaptive and improved services based on the user needs.

The Oslo pilot site has mainly focused on its first use case, “Predictive operations for building management”, for which they have acquired feedback from stakeholders regarding improvements on the presentation of cleaning reports as well as the need for monitoring CO2 levels and visits in the building’s rooms. The new requirements have led to updates on their VAS and web UI, and to the implementation of two new VASs and UI functionalities respectively. The second pilot site in Norway, Tromsø, has continued the operation of the implemented VASs and UIs and offered user support for any technical issues.

In Martim-Longo, VASs and UIs have evolved thanks to close collaboration with the stakeholders. Improved visualization at building level and a sensors’ inventory were implemented for municipal services, while recommendations are now available in the UV for citizens UI. Moreover, climate services have been extended to compute the PV panel efficiency in real-time.

In Pilea-Hortiatis pilot site, a close collaboration was established between the development team, the health professionals (doctor, psychologist, dietician) and the elderly and middle-aged citizens. Updates were performed for all VASs based on technical and functional requirements, with a special focus on the VAS and UI related to the elderly persons’ abnormal behavior detection. The model used for detection was significantly improved in terms of accuracy, while a number of functionalities are now available to the mobile app that provides explainable content on the decisions of the algorithm based on the elder’s behavior.

Finally, BVR has implemented two new VASs and the respective UIs, as a proof of concept of VICINITY Platform. The offered services are related to smart parking and smart building management in the city of Děčín.

All pilot sites reported that the feedback they have received during the VASs operation in real-life conditions, both regarding technical aspects and user experience, was valuable and has contributed both in the improvement of the offered services and the user satisfaction.

Overall, the work conducted for task T5.3 has led to several improvements in technical and business aspects, which were initiated from the close collaboration with the stakeholders of each pilot site. The operation of the VASs in real-life conditions has proven to be challenging and has given the pilot sites the opportunity to evolve and even explore possibilities beyond the initial planning of the use cases implementation.

9. References

[4] D5.1 Value-added services definition requirements and architectural design, online: https://vicinity2020.eu/vicinity/content/d51-value-added-services-definition-requirements-and-architectural-design

[5] D5.2 VICINITY Value Added Services Implementation Framework, online: https://vicinity2020.eu/vicinity/content/d52-vicinity-value-added-services-implementation-framework

[6] GRANT AGREEMENT NUMBER — 688467 — VICINITY, H2020-ICT-2015/H2020-ICT-2015

[7] https://datarob.com/essentials-software-development-life-cycle/

[8] https://www.tpssoft.com/service/maintenance-support

[9] https://vicinity2020.eu/vicinity/

[10] M. Koutli, N. Theologou, A. Tryferidis, D. Tzovaras, "Abnormal Behavior Detection for elderly people living alone leveraging IoT sensors", IEEE BIBE 2019, Athens, Greece, 28-30 October 2019 , DOI: DOI 10.1109/BIBE.2019.00173, Available Online: https://vicinity2020.eu/vicinity/system/files/publications/01_abnormal_behaviour_detection_for_elderly_people_living_alone_leveraging_iot_sensors_certh.pdf

[11] IoT Catalogue - https://www.iot-catalogue.com/

Annex I - Templates

Value-Added Services Template

Examples of completed templates are in Chapters 3-7

VAS x.y	**Name of the VAS**
Related Use Case	Use case related to the VAS
Updates on user requirements	New or changed user requirements
Functionalities upgrades	List of the upgraded functionalities
Corrective maintenance	Bug fixing
Other	

User Interfaces Template

Examples of completed templates are in Chapters 3-7

UI x.y	**Name of the UI**
Related Use Case	Related Use Case for the UI
Updates on user requirements	New or changed user requirements
Functionalities upgrades	List of the upgraded functionalities
Corrective maintenance	Bug fixes
User Support	Action taken regarding user support e.g. phone support for technical issues
Screenshots	Screenshots of final version of UIs, to cover abovementioned functionality upgrades (max 2, if more point to Annex)

Deployment maintenance on site

Example of completed template is in Chapter 6.3

UC	Activities	Reason
UC x.1	Describe maintenance activity 1 (e.g battery replacement of sensors)	Describe the reason for this maintenance e.g. Sensors stopped sending data
	Describe maintenance activity 2	
UC x.2	Describe maintenance activity 1	
	Describe maintenance activity 2	