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Deliverable D8.1

Business Scenarios & Evaluation Framework

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Executive Summary

Work Package 8 of the EU funded project VICINITY contains six tasks. Together they will contribute to the completion of Milestone 9 *Pilot demonstration and overall system evaluation*. This milestone will be met on completion of the report D8.6 *Evaluation of user experience and performance of VICINITY Framework & value-added services*, which is due at the end of the project, Month 48 December 2019.

A review of published methodologies for evaluation was carried out. The proposed methodology is based on the principles of the European Telecommunications Standards Institute (ETSI) Standard TS 103 463 V1.1.1 (2017-07) *Key Performance Indicators for Sustainable Digital Multiservice Cities*. It includes multiple domains, provides a basis for comparative assessments over time and shows how to use the five-point Likert scale when posing questions for stakeholder surveys with examples.

'Interoperability as a service' is a main goal of VICINITY. Value-Added Services (VAS) are designed to demonstrate VICINITY interoperability while unlocking possibilities VICINITY enables. The four pilots operate in different locations in three different countries and operate within and across domains: health, buildings management, transport and energy management. All use the VICINITY platform to set-up point-to-point data sharing between devices connected to their gateways and seek to add novel and opportunistic VAS over the top of the infrastructure. VAS have assigned key performance indicators which will be used for the final evaluations to be reported in the final year of the project.

This report describes how data will be collected from stakeholder surveys and autonomously from the IoT devices connected to the VICINITY Platform. An evaluation checklist has been provided summarizing the key steps for evaluation which are described in this report and are required to make a VICINITY evaluation by the Pilot Site Evaluator or VICINITY Platform Evaluator.

Autonomously collected data will be aggregated for display on the evaluation dashboard both from the VICINITY platform and at the pilot level. In the experimental set-up, metadata, such as number of events per day, are recorded together with how many of these events led to true or false notifications. The usefulness of the dashboard, in providing consolidated data from a number of sources for stakeholder reports or for showcasing will be assessed during the final year of the project.

The evaluation of the VICINITY Platform, its nerve centre, is considered to be an important aspect of the evaluation. To do this, it was necessary to define some additional key performance indicators to those given in Deliverable 5.1 for the Pilots. These are included in this report.

VICINITY offers a platform on which a wide range of unmet needs can be met via the Value-Added Services it enables. The evaluation of these from both technical and stakeholder perspectives will lead to business propositions which can be carried forward after the project ends and will be presented in D9.14 *VICINITY exploitation and business plan, final version* at the end of the project.

In Work Package 9, Open Calls, 1 and 2, from VICINITY have been designed to allow new organisations to join the project to test-out new opportunistic infrastructures and Value-Added Services. These will be evaluated and reported in Work Package 8 during the final year of the project and their future business plans will be reported in D9.14.

Table of Contents

1. Introduction 11
1.1. Context within VICINITY 11
1.2. Overall objectives of this Deliverable D8.1 *Business Scenarios & Evaluation Framework* 13
1.3. Relationship with other Work Packages and Deliverables 14
1.4. Overall Objectives of VICINITY 14

2. Methodology 16
2.1. Methodology for Stakeholder Evaluations 17
2.2. Methodology: Strategic Benefit Evaluation 19
2.3. Methodology: Overall Visualisation of Results 20
2.4. Methodology-Technical Evaluation for VICINITY at Pilot Sites 20
2.5. Methodology-Business Case Evaluation for Pilot Sites 21

3. Evaluation Process 23
3.1. Evaluation Process Phases 23
3.2. Recording Results: The Evaluation Spreadsheet 23
3.3. Security and GDPR Compliance Evaluation 25

4. Sources of Data for Evaluation 26
4.1. Autonomous Data Collection and Evaluation Dashboard 26
4.2. Surveys (via online poll-agency/partner) 28

5. Evaluation of the VICINITY Platform 30

6. Pilot Trial Evaluation Task Plan Summaries 36
6.1. WP8.32 Martim Longo, PO 36
6.2. WP8.3 Oslo Pilot Site, NO 38
6.3. WP8.4 Tromsø, NO 39
6.4. WP8.5 Pilea-Hortatis, GR 40

7. Evaluation results and lessons learned from the VICINITY open calls 44

8. Plans for Task 8.6 *Overall Evaluation of User Experience and Performance of VICINITY framework and tools* 46

9. Evaluation Checklist 53

10. Conclusions 54

11. References 55

12. APPENDICES 57
12.1. Gantt chart for VICINITY Dashboard 57

12.2. Gantt chart for Task 8.2 Realisation and Evaluation of Neighbourhood GRID Ecosystem (Martim Longo) 57
12.3. Gantt chart for Task 8.3 Realisation and Evaluation of Buildings and for Assisted Living Neighbourhood (Oslo Science Park) 58
12.4. Gantt chart for Task 8.4 Realisation of, and Evaluation of, Intelligent Transport and Parking Use Case (Tromsø) 59
12.5. Gantt chart for Task 8.5 Realisation of eHealth at Home Use Case (Pilea-Hortatis) 59
12.6. Gantt chart for Task 8.6 Overall Evaluation of User Experience of VICINITY Framework and Tools 60

Index of Figures

Figure 1 VICINITY architecture showing dataflows 11
Figure 2 Project Status Overview 12
Figure 3 Gantt chart showing Task 8.1 within the Work-package 8 Timeline 13
Figure 4 Proposed graphic to show overall Evaluation Results 20
Figure 5 A portion of the Evaluation Spreadsheet-rescaled for a screenshot 24
Figure 6 Initial Test Version of VICINITY Dashboard 27
Figure 7 VICINITY Evaluation Dashboard Landing Page Example 28
Figure 8 Example of the Results Pane of a Secure Survey 29
Figure 9 The VICINITY Platform 30
Figure 10 The Nagios Dashboard 31
Figure 11 High-level VICINITY architecture overview 33

Index of Tables

Table 1 Summary of the 20 Objectives of the VICINITY Project 15
Table 2 The Four Dimensions for Evaluation in ETSI Standard TS 103 463 V1.1.1 18
Table 3 An Additional dimension from CITYkeys project 18
Table 4 Example of a Survey Question using the Likert Scale 18
Table 5 Evaluation Category and Data Type Recorded 26
Table 6 Example Survey Questions to be Sent to Managers of VICINITY Gateways 32
Table 7 The Two KPIs for Technical Assessment of the two Use cases in the Pilea-Hortatis Pilot Site 41
Table 8 The Two KPIs for the Business Assessment of the two Use cases in the Pilea-Hortatis Pilot Site 43
Table 9 Reporting Periods for the Open Calls 44
Table 10 Example Performance Questionnaire Template for the Open Calls 45
Table 11 Example Performance Questionnaire Template for the Open Calls 45
Table 12 Attributes and Metrics for key Sensor Types in each Pilot 47
Table 13 Further Attributes and Metrics for key Sensor Types in each Pilot 48
Table 14 The information that will be tracked and used in the dashboard for the Tromsø Pilot Site 48
Table 15 The information that will be tracked and used in the dashboard for the Oslo Pilot Site 49
Table 16 The information that will be tracked and used in the dashboard for the Martim Longo Pilot Site 50
Table 17 The information that will be tracked and used in the dashboard for the Oslo Pilot Site 51
Table 18 Information for each of the parameters being monitored and presented on the dashboard per Pilot Site 52
Table 19 Evaluation Checklist 53

List of Definitions & Abbreviations

Abbreviation	Definition
API	Application Programming Interface
CITYkeys	H2020 funded project proposing indicators for Smart City and Communities
D	Deliverable
ECAS	European Commission Authentication System
ETSI	European Telecommunications Standards Institute
EU	European Union
GA	General Assembly
GDPR	General Data Protection Regulation
IEQ	Indoor Environment Quality
IoT	Internet of Things
IoT-EPI	IoT- European Platforms Initiative
ISMS	Information Security Management System
JTC	Joint Technical Committee
KPI	Key Performance Indicator
M	Month
MPH	Municipality of Pilea-Hortiatis
MS	Milestone
OQWAPI	Open Gateway Application Programming Interface
PII	Privacy or Personally identifiable information
P2P	Peer-to-peer
POST	POST is a request method supported by HTTP used by the World Wide Web
PwC	PricewaterhouseCoopers
REST	Representational State Transfer
T	Task
TS	Technical Specification
USP	Unique Selling Point
VAS	Value-Added Service
WP	Work Package

1. Introduction

VICINITY is an EU funded project under the Horizon 2020 framework programme and will last 4 years until the end of 2019. VICINITY aims to solve the problem of lack of interoperability across different disciplines, vendors and standards. The VICINITY Consortium consists of 15 complementary partners from 9 different European Countries: Denmark, Germany, Greece, Norway, Portugal, Slovakia, Slovenia, Spain and the UK.

The goals of this report are to explain how a methodology for evaluation was chosen for VICINITY and to define the processes needed for the evaluation. This is to be carried out in the final year of the project by the 5 remaining Tasks within Work Package 8 (WP8) as detailed in Sections 6 and 8. This report describes how data will be collected from stakeholder surveys and autonomously from the IoT devices connected to the VICINITY Platform.

An Evaluation Checklist is included in Section 9 which summarises the steps needed to perform the evaluation at the level of a pilot trial and at the VICINITY platform level. The process for the evaluation of the Open Calls is given in Section 8.

1.1. Context within VICINITY

The Schematic of VICINITY architecture dataflows is shown in Figure 1. The VICINITY Ethics Board identified the need for this when establishing how the requirements security and privacy under the EU General Data Protection Regulation (GDPR) would be met. VICINITY facilitates the exchange of data between gateway devices at the pilot sites by establishing a mutually agreed peer-to-peer link (P2P) without handling the data content within the VICINITY platform. This is an intrinsic privacy feature of the VICINITY neighbourhood. The P2P links are shown with in Figure 1. Thus, interoperability between two gateways may be achieved without invoking third-party storage.

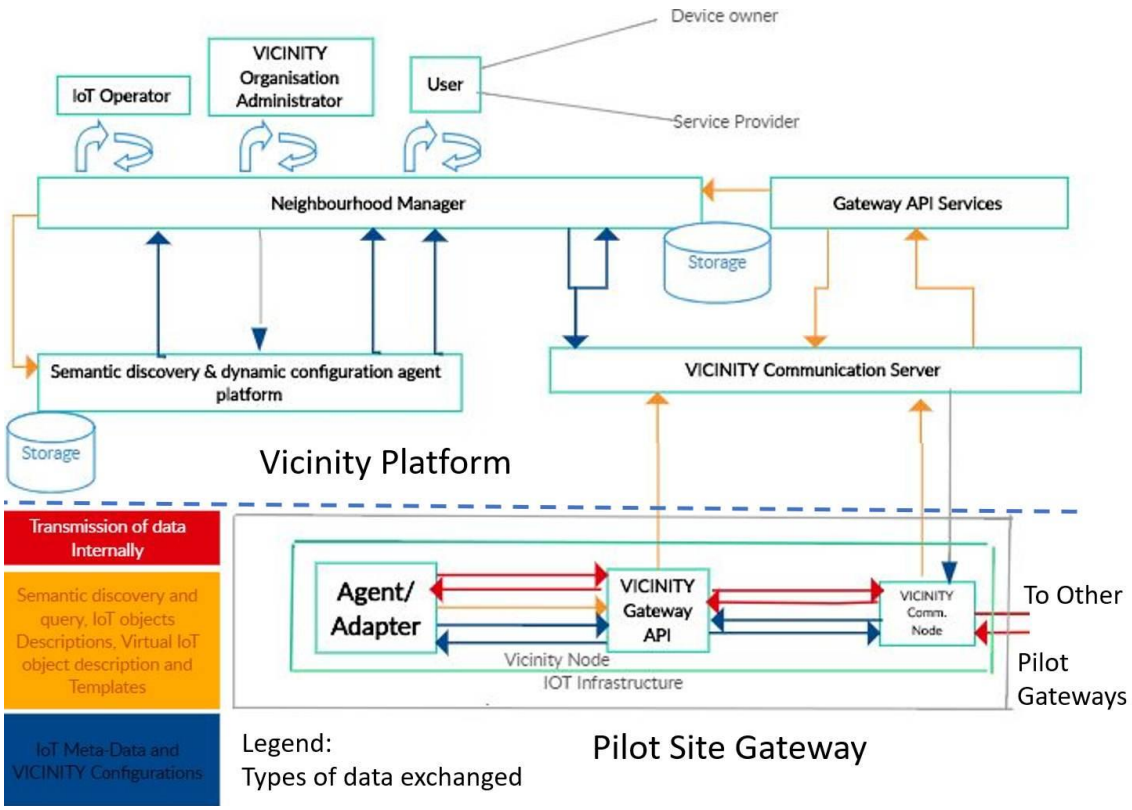

Figure 1 VICINITY architecture showing dataflows

The status of the evaluation WP8 *Pilot Demonstration and Overall Evaluation* is shown in Figure 2 below, which was adapted from a presentation made to the IoT-European Platforms Initiative (IoT-EPI) in April 2018.

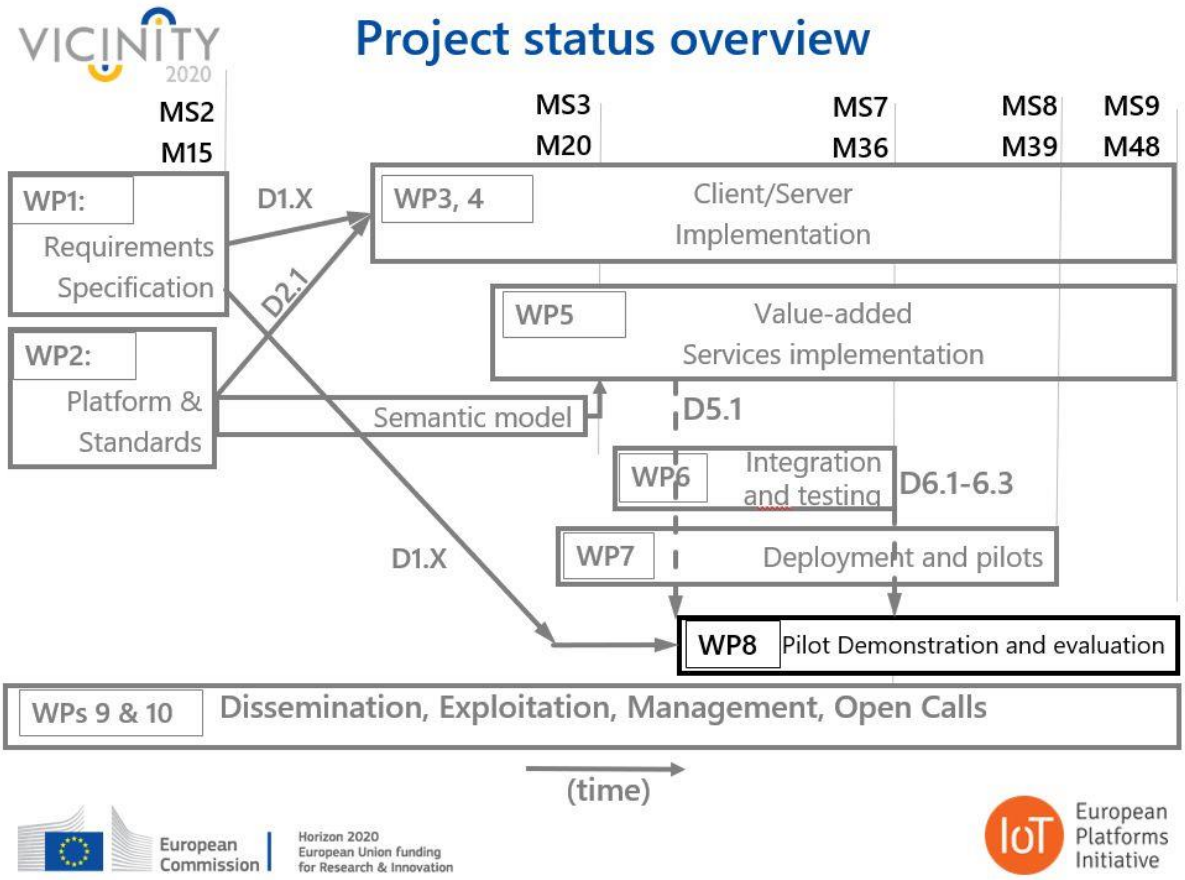

Figure 2 Project Status Overview

As shown in Figure 3, there are 6 tasks within WP8. Each of the tasks will carry out evaluations using the methodology described here and produce a report (a VICINITY Deliverable). The overall Milestone 9 *Pilot demonstration and overall system evaluation* will be met on completion of the report D8.6 *Evaluation of user experience and performance of VICINITY Framework & value-added services,* at the end of the project, in Month 48, December 2019.

The subject of this report is Task 8.1 *Pilot Evaluation Framework Definition* which was operated during the third year of the project (2018). The objective of this task was to provide guidelines for the evaluation of the four pilot trials in Tasks 8.2 to 8.5 and the overall user experience in Task 8.6 during the final year of the project. The activities of the six distinct tasks in WP8 are detailed in Figure 3. T6.1 which is responsible for this report is shown in **bold**. Security, privacy and interoperability are important features for VICINITY evaluation and are discussed in Sections 1.3, and 3 of this report.

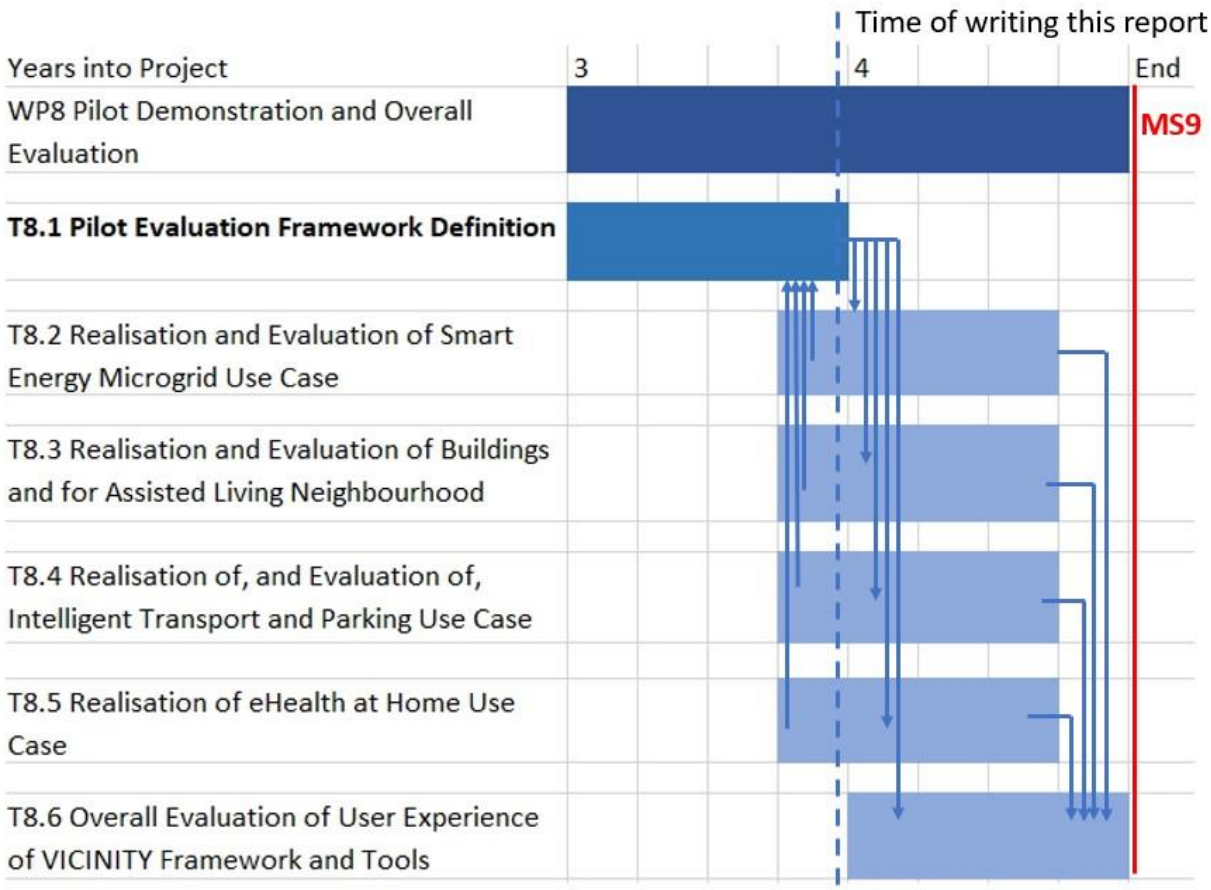

Figure 3 Gantt chart showing Task 8.1 within the Work-package 8 Timeline

1.2. Overall objectives of this Deliverable D8.1 *Business Scenarios & Evaluation Framework*

One of the core activities of VICINITY project is to evaluate its results against the use cases and requirements so as to validate the actual performance and impact of the project framework and identify any gaps and further work required. The goal of WP8 T8.1 was to review and select an evaluation methodology and tools and the processes which are needed to carry out the evaluation. These are reported in Sections 2-5. Business scenarios and use cases that for evaluation are described in D1.4 *Business requirements specification* [1]. The effectiveness of each use case will be assessed via questionnaires so that individual users can provide ratings of the system performance.

The work began by identifying requirements from all previous deliverables [2] and focused them on those which are relevant to evaluation, so as to contribute to the overall evaluation in Deliverable 8.6. For example, in D1.1 *Requirements Capture Framework* [3] a list of non-functional dimensions which relate to evaluation were found. These included: scalability, capacity, availability, maintainability, security, regulatory, environmental impact, data Integrity, usability, interoperability and overall performance. In doing this it was necessary to avoid requirements involving laboratory testing which is the subject of WP6.

In addition, WP8 is required to provide performance indices autonomously within each use case so that data may be recorded in real time, be remotely read and displayed on a real time dashboard. Section 4 identifies requirements for the implementation of the dashboard, so that some aspects of the performance of the VICINITY ecosystem may be evaluated autonomously.

The need to evaluate the VICINITY platform as shown at the upper portion of Figure 1 was identified within Task 8.1. Section 5 has therefore been added to this report to set out requirements for the evaluation of the VICINITY platform. Its performance will be evaluated and reported in T8.6 *Overall Evaluation of User Experience and Performance of VICINITY Framework & Tools*.

1.3. Relationship with other Work Packages and Deliverables

WP1, Deliverables D1.1-D1.5 [2] set out requirements for VICINITY pilots and use-cases which were defined before WP8 started. These have relevance to evaluation as they included the results of questionnaires to stakeholders about their requirements. They can subsequently be contacted again to find out if the requirements were fulfilled.

For example, in D1.4 [3] *Business requirements specification* it is reported that stakeholders regard security and privacy as a common barrier to the interoperability of IoT. Other barriers identified are lack of standards and low level of product maturity from customer standpoint.

It is the responsibility of the managers of the pilots to decide which of the requirements identified in this report need to be followed-up in their evaluations, as many requirements will have been met during laboratory testing in WP6. Questions used to solicit requirements from stakeholders may be suitable for follow-up during the evaluation phase of the project with questions such as “How well was requirement ‘x’ satisfied?”. WP6 *VICINITY Framework Integration & Lab Testing* is due to report in M36, at the same time as this report. Its findings can be taken into account in the evaluations which follow.

The report D5.1 *Value-added services definition, requirements and architectural design* [4] has provided key input to WP8 including details of 16 Value Added Services (VAS)s, together with their goals and key performance indicators. These were the “driver” for the creation of the Evaluation Spreadsheet described in Section 3.

This report, D8.1, provides a methodology and framework for the 5 subtasks T8.2-T8.6 as identified in Figure 3. More details of these tasks are given in Sections 6 and 8.

1.4. Overall Objectives of VICINITY

With regard to the overall evaluation of VICINITY, 22 objectives and 21 Success Criteria were set out at the instigation of the project [5]. Task 8.6 is required to report on the “Overall Evaluation of User Experience and Performance of VICINITY Framework & Tools”. To what extent D8.6 has the main responsibility of reporting the overall outcome of VICINITY is an issue that needs to be determined in cooperation with the Project Coordinator and with WP9 and WP10 leaders, which will also end on M48.

The 22 Objectives are summarised below. Some are very similar, perhaps proposed for several pilots, and may be condensed to the 17 shown **in bold** as common requirements for WP8. The re-evaluation of 5.2 is noted in Table 1.

1. Potential stakeholders are identified and engaged in VICINITY, business drivers and barriers on IoT interoperability are captured and analysed
1.1 Establish Stakeholders Advisory Board
1.2 Establish interoperability requirements
1.3 Evaluate VICINITY with stakeholders
1.4 Elaborate and validate the route to exploitation
2: VICINITY concept defined in compliance to the existing and emerging IoT standards with ambition of contributing to them.
2.1 Optimise using available standards and identify gaps
2.2 Meet regulatory requirements
2.3 Ensure external user devices can connect to the VICINITY Platform
2.4 Capture technical requirements and are traceable
2.5 Contribute to standards where gaps have been identified
3: Open interoperability gateway and web-based Neighbourhood Manager available on the internet
3.1 as 2.3 and with the necessary and privacy
3.2 as 3.1 with the necessary authentication
3.3 Semantic discovery and dynamic configuration features maintained and mapped to gateways
3.4 Advanced trust, security and privacy assuring mechanisms implemented
4: Diverse proprietary IoT infrastructures integrated, Decentralized interoperability demonstrated
4.1 Implement demand-side management
4.2 as 2.3 for smart buildings
4.3 as 2.3 for smart parking
4.4 as 2.3 for e-health
4.5 Implement open calls
5: Value-added services explored and demonstrated
5.1 Ensure KPIs are accessible to users
5.2 as 4.1 with micro trading (This requirement was changed this during the course of the project as reflected in D1.3 and in D5.1. Micro trading is not possible at the moment, but there are alternatives)
5.3 Implement the control system for smart parking
5.4 as 4.5

Table 1 Summary of the 20 Objectives of the VICINITY Project

2. Methodology

WP8 is required to assess the technical feasibility and effectiveness of each use case via questionnaires so that individual users can provide ratings of the system performance. The choice of methodology for evaluation was discussed during online meetings and the findings are summarised below. A standards-based approach was favoured. A 'tried and tested' approach as is achieved during the consensus-building process of standardisation reduces the risk of failure. The following standards were reviewed during online meetings and the most applicable one was selected and communicated to the team.

Three ISO standards were reviewed which were:

- ISO/IEC CD 15048-1 *Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 1: Introduction and general model* [6].

This standard is currently under review. The latest draft is available from ISO/IEC or experts participating in JTC1 SC27/WG3. It is a useful reference, and is essential for large organisations such as a bank. It was considered to be too heavyweight for VICINITY which is at the research phase.

- ISO/IEC CD 30141 ISO/IEC JTC 1/SC41 *Internet of Things (IoT) -- Reference Architecture (IoT RA) [7]*

This standard is available on subscription from the IEC Secretariat. It provides good conceptual model with engineering guidelines for VICINITY developers. The main shortcoming of the standard is that it defines 'domain' differently from VICINITY. There is no reference to interactions between domains like health and transport which is the value-added VICINITY (and ITU-T FG-DPM) aims to provide.

- ISO/IEC WD2 27030 ISO/IEC JTC1/SC27/WG4 *Information technology – Security techniques – Guidelines for security and privacy in Internet of Things (IoT)*

This standard is yet to be published but is available on subscription from JTC1/SC27. It is derived from "trustworthy" drafts being developed in IEC/SC41. Information security is a major concern of any information and communication technology (ICT) system and Internet of Things (IoT) systems are no exception. IoT systems present particular challenges for information security in that they are highly distributed and involve a large number of diverse entities. This implies that there is a very large attack surface and a significant challenge for the Information Security Management System (ISMS) to apply and maintain appropriate security controls across the whole system. Privacy or Personally Identifiable Information (PII) protection is a significant concern for some types of IoT system. Where an IoT system acquires or uses PII, it is usually the case that there are laws and regulations that apply to the acquisition, storage and processing of PII, which the IoT system needs to comply with. Even where regulations are not a concern, the handling of PII by an IoT system remains a reputational and trust concern for the organization involved, for example if the PII is stolen or is misused, potentially causing some form of harm to the people identified by the information.

In addition, a set of ITU Recommendations was reviewed as detailed below.

- ITU L.1600 series of Recommendations [8]
  - L.1600 *Key Performance Indicators for Sustainable Digital Multiservice Cities*
  - L.1601 *Key performance indicators related to the use of information and communication technology in smart sustainable cities*
  - L.1602 *Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities*
  - L.1603 *Evaluation and assessment Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals*

This series of Recommendations is freely available and provides a classification system and a wide range of indicators are described. Of these, L.1603 is the most useful, because it also provides the unit of measure. However, there is no methodology on how these indicators may be evaluated.

ETSI standards are mandatory in Europe. The following was identified as the most relevant to VICINITY evaluations.

- (ETSI) Standard TS 103 463 V1.1.1 (2017-07) *Key Performance Indicators for Sustainable Digital Multiservice Cities* [9]

This standard is freely available. The focus of this standard is on how to carry out stakeholder surveys in different domains. The principles are easy to follow and these are ideal for a Research and Innovation project such as VICINITY. The majority of VICINITY evaluations will be carried out in this way. It offers a step by step approach and is discussed further in Section 2.1 below.

The ultimate goal of this standard is to support the wide-scale deployment of smart city solutions and services in order to create impact on major societal challenges related to the cities' fast growth and the Union's 20/20/20 energy and climate targets. VICINITY is expected to play its part in this goal and by adopting the standard can track its progress towards this goal.

2.1. Methodology for Stakeholder Evaluations

2.1.1. ETSI Standard TS 103 463 V1.1.1 (2017-07).

The methodology for evaluation of VICINITY pilots, will be based upon the principles of the European Telecommunications Standards Institute (ETSI) Standard TS 103 463 V1.1.1 (2017-07) *Key Performance Indicators for Sustainable Digital Multiservice Cities* [9]. This enables performance indicators to be selected from four domains. This standard was formed by industry consensus and is based upon contributions from the CITYkeys project [10]. As a standard, this supersedes the Citykeys deliverables [10] which have contributed to it. The dimensions and perspectives in this standard are:

People
- Encouraging a healthy lifestyle
- Cybersecurity
- Data privacy
- Digital literacy
- Ground floor usage

Planet
- Domestic material consumption
- Brownfield use
- Local food production
- Urban heat island

Prosperity
- Share of certified companies
- Innovation hubs in the city
- Open data
Governance
- Smart city policy

Table 2 The Four Dimensions for Evaluation in ETSI Standard TS 103 463 V1.1.1

An additional dimension and perspective from the CITYkeys project [10] which is applicable to VICINITY is shown here.

Propagation
- replicability, scalability and success factors

Table 3 An Additional dimension from CITYkeys project

The approach for VICINITY was to select relevant key performance indicators (KPIs), as defined for each value-added service in D5.1. The evaluation methodology will establish whether the VAS and its associated infrastructure is "fit for purpose". Questions can then be phrased on each of the KPIs to establish whether or not the service is giving user-satisfaction. Both "with" and "without" evaluations are required, with the latter serving as a control. Further evaluations can be made periodically, to show how the indicators change going forward in time.

The control will allow a comparison to be made between the "business-as-usual" situation (the "without VICINITY" scenario) with the results of the trial so that the benefit of VICINITY can be determined. The users in the control will have an "unmet need" which is subsequently met by the inclusion in the VICINITY project and trial.

It was decided to adopt the five-point Likert scale for questionnaires as described in the ETSI standard [9], and to adopt this for all questionnaires in WP8. An example question is given in Table 1 below.

Are you satisfied with the service you have received in the VICINITY trial? (Check one box)				
1 (Not at All)	2	3	4	5 (Very much)
				Y

Table 4 Example of a Survey Question using the Likert Scale

A checkpoint is scheduled for the mid-trial stage, month M39, which will allow sufficient time to make improvements and report the overall findings in D8.6.

The principles for evaluation are well-described in the ETSI standard but must be developed and adapted to suit the evaluation requirements of each of the pilots or the VICINITY platform as given by the KPIs for the VASs which are defined in D5.1 [4].

Specific dimensions which are not the focus of the ETSI standard or CITYkeys but which are relevant to VICINITY are:

- Health

- Assisted living, healthy lifestyle

- Transport
  - Smart Parking, energy efficiency and use of resources
- Smart Appliances
  - Performance of white goods (refrigerators, ovens etc.) and cross-domain benefits
- Smart buildings
  - Energy efficiency, Manpower efficiency, Interior environmental quality, Municipal buildings operations efficiency
- Smart Technology
  - IoT and interoperability
- Innovation
  - Via the Unique Selling Point (USP)
- Smart operations and maintenance of distributed renewable energy production

KPIs for VICINITY evaluation are set out in D5.1 as detailed for 15 Value-Added Services. These relate to one or more of these dimensions. They will only appear in the surveys where they are relevant. The dimensions are mentioned here to ensure the evaluation does not miss the opportunity to gather feedback on an important aspect such as 'innovation' because it has not been already included in the list of KPIs in D5.1. They will be evaluated either autonomously or via surveys as described in Section 4.

2.2. Methodology: Strategic Benefit Evaluation

Having established whether a VAS is "fit for purpose" via the user questionnaire and autonomous data collection as detailed below, the methodology for reporting the evaluation may be developed further by considering strategic benefits to the EU. The report *Cross-cutting business models for IoT*, the final report for DG Communications Networks, Content and Technology, by PricewaterhouseCoopers (PwC) [11] has been proposed as a guide to this aspect of the evaluation.

This "focuses on identifying promising areas for cross-cutting Internet of Things (IoT) activities and their corresponding business models. Market and technology-related success factors and barriers, as well as the social impact of IoT, are analysed".

Although it is aimed at top-level governance it is relevant to the VICINITY pilots, "Attention should be paid to a more strategic allocation of government funding and to barrier-removing initiatives such as pilots, alliances and educational programmes" and "the risks related to infrastructure need to be mitigated by developing strategic public–private partnerships".

A similar approach will be used to gather qualitative information from stakeholders and present the results in a strategic business context. This involves activities such as interviews and workshops.

It has been recommended that this report acts as a guide for evaluation of VICINITY at the business level. This business evaluation will be conducted by analysis and interview.

2.3. Methodology: Overall Visualisation of Results

A graphical representation of the overall results has been proposed and discussed by the WP8 team. This gives a simple snapshot summary of the results. The example given below in Figure 4, shows 6 key dimensions which are relevant to all four pilots. Results of all four pilot site demonstrations are shown and the 5-point Likert scale is used to provide scaling from the centre outwards. The four symbols at the top act as reminders of the location of the demonstration site and which is its primary domain of operation.

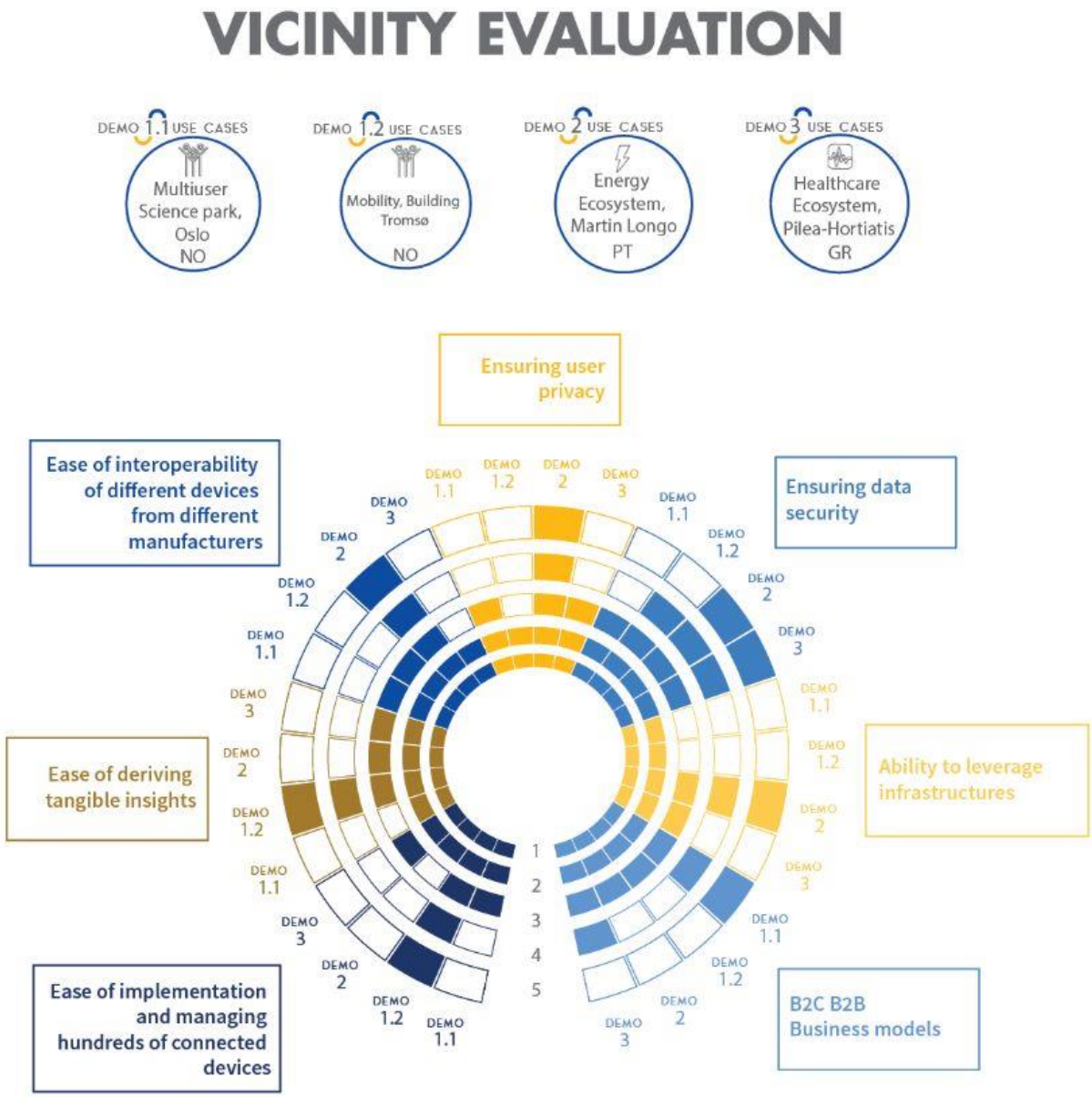

Figure 4 Proposed graphic to show overall Evaluation Results

2.4. Methodology-Technical Evaluation for VICINITY at Pilot Sites

The methodology above presents an overview of how the results of VICINITY evaluation will be gathered and presented in future deliverables and to relevant officials in local government, infrastructure owners and end-users.

For the pilot sites and/or their associated value-added services, in addition to evaluating the specific KPIs in D5.1 [4] the following general technical questions must be considered:

• What functionality will be tested?

• Did the Test beds & Pilots provide the intended functionality and how well do they compare with the control (absence of the VICINITY VAS)? Explain any issues if some aspects of the intended functionality could not be delivered.

• Did it pass cyber-security tests?

• Did it pass GDPR tests?

• What corrections to the design were needed e.g. as a result of lab testing or at the mid-point evaluation?

• Did any of these changes require a change to the VICINITY Architecture?

2.5. Methodology-Business Case Evaluation for Pilot Sites

The business case evaluation is aimed at finding out if a service being offered in the pilots is meeting a need that has never been identified before or is providing a more convenient solution to a known problem.

The evaluation of business case propositions must draw upon requirements expressed in Deliverable D1.4 *VICINITY business requirements specification* [1] , VICINITY in D5.1 *Definition of value-added services per use-case* [4] and *D9.5 VICINITY exploitation and business plan* [12].

- D1.4 identifies a set of business requirements per VICINITY domain. These are buildings, energy transport and health.
- D5.1 identifies a set of value-added services, which are implemented via software, together with their KPIs which may operate in one or more pilot sites.
- D9.5 provides a perspective how VICINITY partners plan to exploit their VICINITY results, as groups or separately on completion of the project.

VICINITY is designed to facilitate “value-add” by allowing data to be shared in novel ways with at least 10 business cases and 10 value-added services to be identified with stakeholders and implemented in Year 4. The overall responsibility for reporting these is in WP10 “Project management” as in the introductory presentation made in the Technical Check in Brussels, April 2018.

D5.1 [4] identifies 15 value-added services together with their KPIs. These have been listed as items for evaluation in the WP8 Evaluation Spreadsheet which is discussed in Section 3.2. One VAS for MPH Pilot site is used for both use cases of MPH Pilot Site, which reduces the total number to 14.

To bring focus to the business evaluation, of the pilots, their use case infrastructure and associated value-added services, the following business aspects must be considered:

• What unmet user need will be addressed? What benefits are intended to be delivered by the pilot to the user? Did other stakeholders also gain benefit?

• Did the users and stakeholders find the system easy to use?

• Did they get real value using the service? (i.e. would choose to pay for it after the trial)

• Did they find any usability issues?

• How will the impact of the Pilot be measured (for users and other stakeholders)?

• What qualitative benefits did this deliver?

• Did the operation of the pilot service deliver the expected improvements (in terms of manpower saved, energy saved, etc. compared with the control)?

• What quantitative benefits did this deliver (compared with the control)?

•What would be the costs of providing the VICINITY service beyond the trial?

To answer the last question, the future cost of the sensors can be discounted against volumetric pricing trends for the electronics industry and, together with operational cost estimates the: net profit; year to break-even; and the return on investment over the lifecycle may be estimated.

3. Evaluation Process

3.1. Evaluation Process Phases

The evaluation process comprises three phases.

3.1.1. "Control" Scenario

The control provides a benchmark against which VICINITY is evaluated. The control is a set of users who have no VICINITY service, but are similar in characteristics to those selected for the VICINITY trial.

Control evaluations will be used to establish the difference between those who have VICINITY and those without, so that any benefits can be highlighted. The key difference should reflect the "unmet business need".

Data is gathered via questionnaires during the mid-trial and final evaluations

3.1.2. Mid-trial evaluation (M39)

The aim of this evaluation is to check that the VICINITY platform is "fit for purpose" and to identify any problems which can be fixed during the project.

Data is gathered

- autonomously from metadata arising from the IoT devices or gateways
- from questionnaires from users and stakeholders. Ideally, some of the same stakeholders will be consulted to note any improvement/failings using relevant questions from before
- from workshops and on-site meetings

3.1.3. Final evaluation (M45)

The aim of this evaluation is to find out how well VICINITY performed at the end of the trial and to establish business models for the future. This is similar to the above but all the KPIs set out in D5.1 and the top-level questions in Section 2 must be considered.

Data is gathered

- autonomously from metadata arising from the IoT devices or gateways
- from questionnaires from users and stakeholders. Ideally, some of the same stakeholders will be consulted to note any improvement/failings using relevant questions from before

3.2. Recording Results: The Evaluation Spreadsheet

The evaluation spreadsheet was created to record systematically the results of evaluation in a single tabulated format. Evaluation sheets include the Value-Added Services, the current status of the pilots, the evaluation of VICINITY Neighbourhood Manager, and the most relevant standards.

The starting point was to recreate the list of VASs from D5.1, their goals and KPIs. The spreadsheet was then updated to include additional details which are important for evaluation of each VAS. These included answers to the following questions:

- Where is the pilot site?
- Is the VAS cross domain?
- Which domain or domains?
- Was the unmet business need identified and has it been satisfied?

- How well did the use case or VAS perform in relation to the KPIs defined D5.1 (Note some of these needed to be updated to become measurable and others were added)
- What is the Unique Selling Point?
- Has the technology been tested before installation?
- What performance measurements were made during pre-trial tests?
- What is the functionality being tested in the trial which is about to start?
- What is the 'Control Scenario' to run in parallel with the trial?

So far in the project, the Unmet Business Needs and USPs and Unique Selling Points had not been identified at the level of value-added services, so this information was added to the spreadsheet. A screenshot showing a small portion of the Evaluation Spreadsheet is shown in Figure 5. This covers two of the VASs, at the Oslo Pilot Site.

Responsibility for the VAS	Is this VAS Cross-Domain? Y/N/Comment	What is the Unmet Need?	KPIs	What is the USP?	Has the technology been tested before installation? Y/N	Note here types of performance measurements made during pre-trial tests?	What is the functionality being tested in the trial which is about to start?
Oslo - Norway	Y - combines data from weather service (external) with door sensor data	Cleaners waste time going to rooms which have not been occupied. They lack information about critical situations, and cannot respond accordingly/target their efforts.	• Number of cleanings avoided (as compared to previous regime) • Number of waste removals avoided (as compared to previous regime) • Number of unnecessary inspections avoided (compared to previous regime) • Number of critical situations handled based on alarms • Tenant satisfaction (toilet/meeting room cleanliness – survey) • Cleaning/waste removal team satisfaction (survey)	Uses IoT to make building cleaning and waste removal more efficient so saves cost of personnel.	Sensors deployed in other applications for similar purpose (minibar systems), but not integrated with external systems	Event driven data from door sensors	Processing of data from door sensors to estimate cleaning need --> statistics, priority lists and alarms. Coupling with weather data to correct for rain or snow, i.e. "dirty" weather.
Oslo - Norway	Y - combines data from weather service (external) with water/electricity meter data	Building managers are not able to identify and respond to electricity demand peaks to shift or shed loads. This causes them to pay a premium on load factor tariffs to the grid owner. Moreover, the lack of a weather service integration leaves the building manager unable to predict upcoming demand peaks (cold weather, hot weather) and take appropriate actions.	• Money saved on reduced load factor tariffs • Reduction in kW of highest monthly electricity peak load • Number of water leaks discovered • Money saved on accurate tenant billing • Time saved by avoiding manual meter readings • Number of peak loads identified and alarmed by service • Manager satisfaction (survey)	Uses IoT to make building energy management more efficient reducing cost of energy supply.	Devices are in use, but not connected as in the VICINITY use case	Meter readings are updated every minute and if non-typical situation arise alarms are triggered.	Processing data from 1) Electricity meters and weather service to: a) Track electricity consumption b) Predict upcoming high demand situations based on weather forecast and historical electricity data c) Control smart appliance (reduce output) automatically if electricity peak is detected 2) Water meters to: a) Detect leaks and/or careless consumption

Figure 5 A portion of the Evaluation Spreadsheet-rescaled for a screenshot

As mentioned before, the focus of this deliverable is mainly on pilots however, there is a need to evaluate the VICINITY platform and its components. More specifically evaluation of Neighbourhood Manager, part of VICINITY Cloud. This evaluation requires a number of questions to be defined in order to ensure that the VICINITY Platform is providing the functionalities promised such as: ease of implementation, efficiency and interoperability.

It is essential to define the usability, reliability and the ease of integration for a company using VICINITY Platform when a new VAS or device is added. VICINITY builds on W3C WoT standard frame of Thing Ecosystem Description (TED) [12] which describes the set of 'Things' for a better understanding of data exchanged. The sequence of interactions for discovery of the available semantic models should be efficient to follow. Other questions that need to be defined refer to security and privacy issues; for example, the extent encryption is used for security and how privacy is ensured so that the requirements of the EU GDPR

are met. Standards used for each Value-Added Service that were first defined in *D1.3 Report on Pilot sites and Operational Requirements* are also clearly marked in the evaluation spreadsheet.

Section 5 has been added to this report to set out requirements for the evaluation of the VICINITY platform.

3.3. Security and GDPR Compliance Evaluation

One of the key features of the VICINITY concept is the full preservation of user's privacy. The platform user can decide which of his/her IoT asset is accessible to which other VICINITY user. User-sensitive data remains stored at user's premises and can be shared only upon user approval at the edge of VICINITY neighbourhood network. Data used for evaluation purposes will be anonymised. Platform security and privacy features were described in D1.3 will be reported in D6.4 *Security and Privacy Evaluation of VICINITY Components*.

The principles for GDPR VICINITY compliance follow the 20 Step Process described by the British Standards Institute white paper *EU General Data Protection Regulation (GDPR) 20 steps to GDPR compliance* [14]. To supplement this, an internal briefing on this was drafted which also included, a set of definitions and a 20-point checklist.

Whilst this established a methodology for compliance within the project and the pilots, it does not describe what steps are needed to ensure the technologies within the VICINITY platform itself can enable GDPR compliance.

To do this the need for a special value-added service was identified for the use case *eHealth and Assisted Living for elderly people at home*. This is VAS 3.1.1 as described in D5.1. *Value-Added Services definition, requirements and architectural design* [4]. The aim of this is to demonstrate the integration of VICINITY with the recently introduced data regulations.

VAS 3.1.1 gathers the data coming from devices in the building and personal devices, deployed in-the home and is responsible for storing them in a secure repository/database system so that they become accessible for further processing by other VASs. Access to raw data is given over a secured protocol, and not via a non-secure server-cloud. Taking advantage of the VICINITY architecture, the communication between the VICINITY nodes using the VAS and the VAS itself is via the VICINITY P2P (Peer to peer) network.

The service includes auditing of the data transaction and access control mechanisms for the user (e.g. a relative of the elderly citizen) to have absolute control of who can access the data (concept of consent). In addition, the service guarantees the compliance with the "right to be forgotten", meaning that in the case of a user wishing to delete his/her account, all relevant data and audit logs will be deleted as well.

Task 6.4 *Security and Privacy Evaluation of VICINITY Components* is due to report at the end of the project in D6.4.

4. Sources of Data for Evaluation

Sources of Data for Evaluation include results of surveys (e.g. via questionnaires) and autonomously collected data from the IoT devices which will be used in the evaluation dashboard as described in Section 4.1 below. Different categories for evaluation are noted in Table 5 below.

Evaluation Category	Examples of data type recorded
Results of laboratory testing and 'hackathons'	VAS success/failure Performance (time/throughput etc)
Results project reviews	Minutes and action for changes to be made
IoT Devices and gateways	Connectivity achieved, Autonomous metadata collection, location, battery level, etc
Stakeholder satisfaction	Results of interviews, questionnaires, surveys
Degree of compliance with Standards*	Which standards are used, gaps identified
How well security and privacy requirements are met	Resistance to hacking, GDPR compliance
Accessibility and Ethics	Degree of social inclusivity Degree risk of social discrimination
Assessment of business benefits and value chains	Scalability, costs, time to break-even
"Control", "During" and "After" Scenarios	User experience surveys
Usage performance	Number of necessary/unnecessary alerts

Table 5 Evaluation Category and Data Type Recorded

* The evaluation spreadsheet includes a page which identifies key standards used in the setting up and use of infrastructure and the VAS such as the environmental standard which need to be maintained.

4.1. Autonomous Data Collection and Evaluation Dashboard

WP8 is required to provide performance indices autonomously within each use case so that data may be recorded in real time and be remotely read by the network management system using a real time dashboard. Examples of best-practice for dashboard creation are given in [15]. Its purpose will be to showcase the activity on VICINITY and to provide metrics for evaluation such as the number of events recorded per day or week as illustrated in Figure 6.

At the time of writing, the dashboard was released in its first prototype version for internal review and testing. As depicted in the Gantt chart, Annex 11.1, the dashboard is ready to receive events and data from the pilots. Integration of the Reporting Mechanisms from the pilot sites is planned for the next two months (M37-M38). Integration will continue as the pilot site installations evolve. Initial bug-fixing, new features and UI improvements are intended for the same period, in close contact with the pilot site operators. The first release of the Dashboard is planned for the end of M38. Development and data logging will continue until the end of the project.

Performance metrics have been defined in Section 6 some of which are suitable for autonomous capturing and reporting. Events to be logged by the pilots are defined in Section 8. This data must be sent to the dashboard on a regular basis. The dashboard itself will enable various kinds of data analysis. At the time of

writing, information is presented on a “per pilot” basis whereby each metric is displayed as a separate graph per pilot site as in Figure 6.

A more fine-grained selection is also possible in a later stage of development and will enable deeper analysis and understanding of the VICINITY platform’s operational status and provided benefit. An automated alert sent out to either a pilot site or VICINITY operator is also possible, if for example, the number of anomalous events exceed a certain threshold across all pilots. This enables a higher-level view of VICINITYs current operational status, which would not be possible with one pilot on its own.

The dashboard will offer an authenticated reporting “REST” endpoint for each pilot site to report to. On a technical level, reporting metrics simply come down to “POST”ing measurements to their respective endpoints. As an example, the Oslo Science Park is required to report its measurements to

POST /vicinity-dashboard/Pilot/Oslo

The corresponding payload should contain a timestamp, the metric observed and the respective value. This information is then displayed as shown in Figure 6.

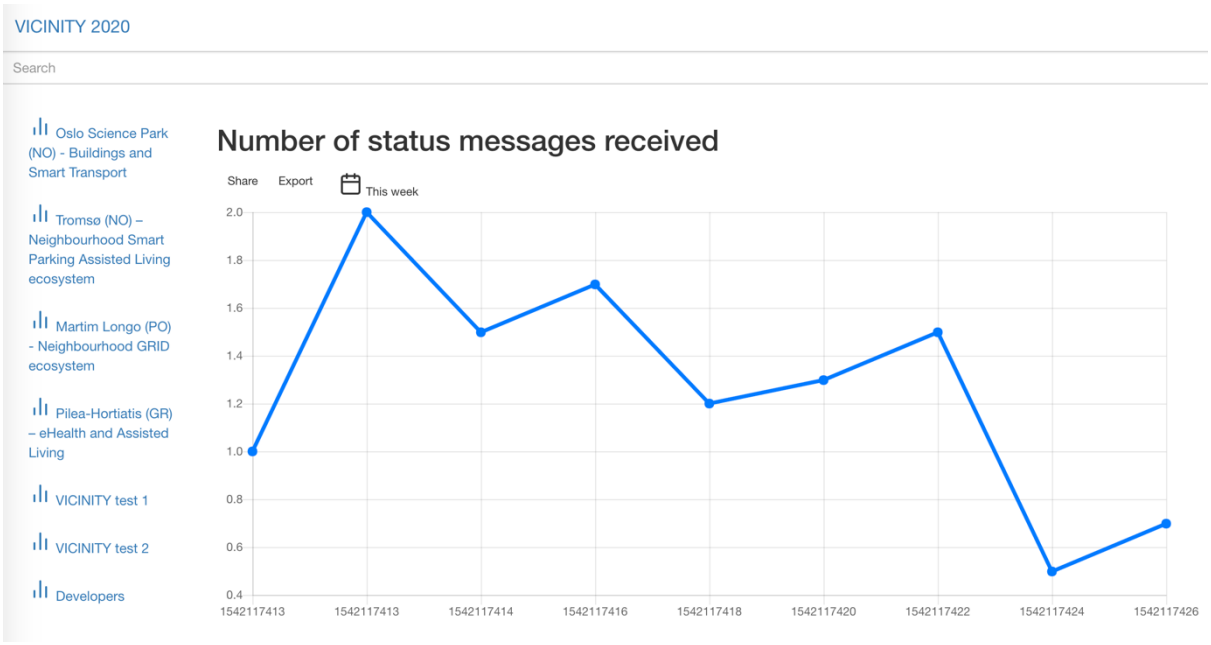

Figure 6 Initial Test Version of VICINITY Dashboard

After all pilots have agreed upon which metrics they can report automatically, further classifications and data aggregation is possible (e.g. by domain).

An example of a possible enhancement to the landing page for VICINITY evaluation is shown in Figure 7. The icons indicate the domain, which may be selected. It is intended that the dashboard will show, in real time, the usage and performance of the pilot. Note that there is no obligation to make dashboards public, for example if there is a risk of personally attributable data being revealed.

Figure 7 VICINITY Evaluation Dashboard Landing Page Example

4.2. Surveys (via online poll-agency/partner)

Candidate survey agencies were reviewed during T8.1 tele-conferences that were held during June 2018. Each offers an online questionnaire service.

Google Forms [16] provide a simple approach but does not offer privacy with anonymised input. Analysis includes simple pie charts. This solution can be used when the source of the data does not need to be private, or it could be used where the data is entered by a single person following or during interviews to ensure anonymity.

Five other online review agencies were considered but all are paid-for and would incur cost to VICINITY.

However, there is a front-runner, EUSurvey [17]. This is widely used by the EC, is hosted on an EC website, and is available free-of-charge to the VICINITY partners. It offers privacy and anonymisation and, as such, allows data to be gathered online, following a personal email invitation. The EUSurvey was therefore tested to find out how to use it and how suitable a tool it is for VICINITY evaluations.

Two tests were carried out. It was decided to adopt the five-point Likert scale as described in the ETSI standard , (1=not all to… 5 =very much) and to adopt this for all questionnaires in WP8. A trial was carried out to assess the suitability of EUSurvey for VICINITY. To do this, two test surveys were carried out to gather evaluation feedback on the series of T8.1 Teleconferences.

The first test did not maintain personal anonymity, i.e. no address book was imported into EUSurvey. This type of survey is “Open” and may be emailed to any participant by including the link to the relevant EUSurvey.

For the second test an address book was imported so that invitations are sent out by email by EUSurvey by selecting a “Secure survey”. Anonymity of the responses is maintained within EUSurvey and only one vote per email is permitted.

As a result of the tests the following advantages of EUSurvey for VICINITY partners were noted:

Ease of use, for Open surveys.

Allows collaborators to cooperate in generating forms.

Privacy can be assured (GDPR Compliant).

Emails to recipients to maintain anonymity of responses and single voting.

Allows all EU languages to be added.

Free of charge to European Commission Authentication System (ECAS) users (VICINITY Partners).

Provides online collection of data and analysis of results.

Online training is available and it is recommended that anyone new to EUSurvey follows this and carries test surveys both open and secure (if required). An Open survey would be used when results are obtained by personal interviews and/or online. A Secure survey would be used where anonymity needs to be maintained. Approximately 5 days training is recommended for new users to become familiar with the system. Breaks are needed within the 5 day allocation to allow for test runs and responses to be collected.

An example of a result-pane from a Secure Survey is shown in Figure 8. This screenshot shows the responses to the first 5 of 10 questions on the series of 15 WP8 teleconferences. The feedback received allowed improvements to be made in the way these teleconferences were conducted and summarised. Incentives are being considered for the evaluation of some pilots to encourage participation in surveys and so enable improvements identified and remedied.

For performance reasons you

Actions	Approximately how many telcos have you attended	It is easy to identify who is speaking	The sound quality is OK	The topics are relevant to T8.1 Pilot Evaluation Framework Definition	The timekeeping is good
	All Values	All Values	All Values	All Values	All Values
					finish on time
	3	All of them	Most of the time	Mostly	All of the meetings finish on time
	3	Most of them	Never	Occasionally	Most of the meetings finish on time
	3	Most of them	Most of the time	Half of the time	Most of the meetings finish on time
	6	All of them	Most of the time	Mostly	Most of the meetings finish on time
	9	All of them	All of the time	Always	All of the meetings finish on time
	3	Most of them	Most of the time	Mostly	Most of the meetings finish on time
	12	Most of them	Most of the time	Mostly	Most of the meetings finish on time
	12	All of them	All of the time	Always	All of the meetings finish on time
	12	Most of them	Most of the time	Mostly	All of the meetings finish on time

Figure 8 Example of the Results Pane of a Secure Survey

5. Evaluation of the VICINITY Platform

The evaluation of the VICINITY platform is within the scope of Task 8.*6 Overall Evaluation of User Experience and Performance of VICINITY Framework and Tools* which begins in the final year of the project.

The VICINITY Platform includes components within the VICINITY cloud which are responsible for setting up the connections for data sharing; these are: The Neighbourhood Manager, Semantic Discovery and Dynamic Configuration Agent Platform, The VICINITY Organisation Administrator, The Gateway APi Services and The VICINITY Communication Server. These are shown in Figure 9 which was produced to show the architecture for GDPR compliance [18].

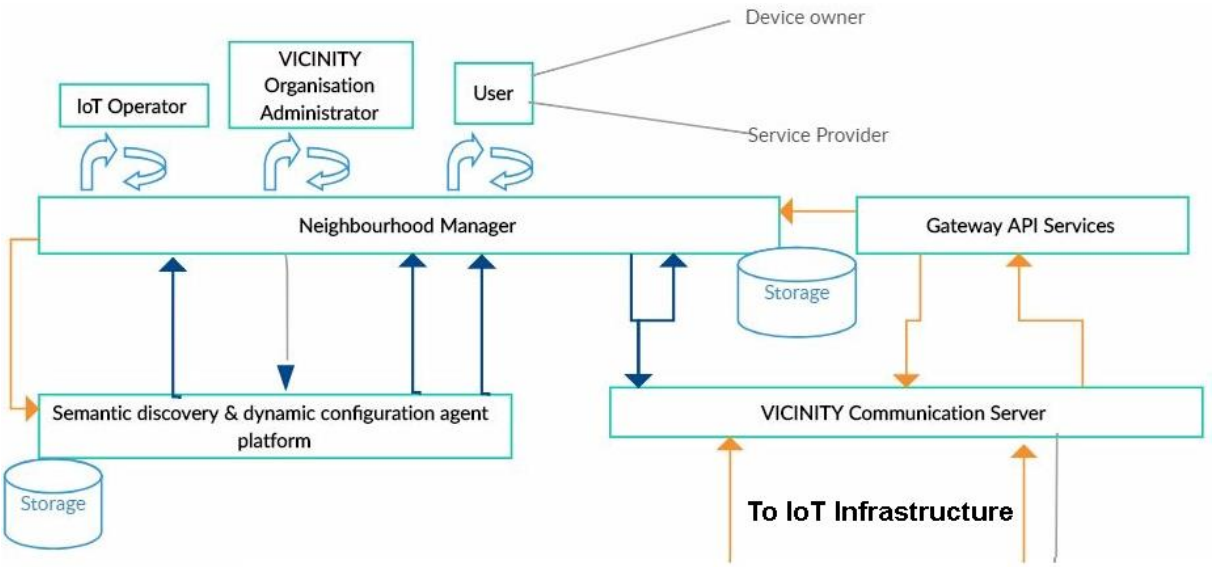

Figure 9 The VICINITY Platform

The purpose of this evaluation is to determine how well the "Brain" of VICINITY is working.

The current status and availability of devices within the VICINITY platform is recorded on the Nagios Dashboard as illustrated in Figure 10. The green boxes indicate that the device is operating correctly, yellow is a warning and red is a critical warning that maintenance is needed. It is intended that metrics such as the overall status and usage of the platform will be sent to the evaluation dashboard as discussed in Section 4.1

Figure 10 The Nagios Dashboard

However, this is insufficient for an overall evaluation which needs the perspectives of user experience and business development. An overall evaluation requires opinions to be obtained via questionnaires directed towards the appropriate stakeholders.

The following set of questions relating to these aspects was therefore identified and are listed on the Evaluation Spreadsheet. These questions will be directed at the managers of VICINITY gateways. The results of these will be reported in D8.6.

User Experience Survey to evaluate the VICINITY Platform
How easy is for a new company to use VICINITY Platform to use new devices and VASs?
How quickly can a new VAS/device be added?
How many semantic models are available?
How scalable is the platform? (number of pilots/devices)
Can the requirements for security and privacy (the EU GDPR) be met?
How secure is the VICINITY platform (to what extent is encryption used)?
Are users satisfied (user experience)?
How is reliability ensured? For example, is the neighbourhood manager duplicated with automatic switchover?

Table 6 Example Survey Questions to be Sent to Managers of VICINITY Gateways

5.1.1. Description of the unmet business need at VICINITY Platform Level

At the VICINITY level, the unmet business needs follow from its unique selling point (USP) as obtained from D5.1[4]. "VICINITY's USP is its ability to enable data to be shared between a wide variety of devices by ensuring semantic interoperability among them at the metadata level so that the contents of the data can follow a separate path from the VICINITY platform to ensure privacy".

From this, the unmet business needs of VICINITY may be identified as described in [19]. This is its ability to enable data to be shared and interpreted across domains (e.g. market sectors). In [20] this is explained as follows:

"VICINITY, aims at providing a decentralized bottom-up ecosystem that offers "Interoperability as a service". In VICINITY, the users share – like in social networks – access to their devices and the data these devices gather and produce. On a local gateway device, a VICINITY Agent is running, together with adapter modules, taking care of the necessary translation between encrypting and enriching shared objects with metadata, in order to enable interoperability as a service to existing IoT deployments. VICINITY does not aim to introduce yet another standard for the IoT. Instead, a strong emphasis is put on monitoring, adapting and contributing to existing standards."

Without the VICINITY Platform, data may only be shared within a single domain (market sector) via devices which have been designed to be interoperable within the context of that domain but have data formatted in a unique way which does not allow straightforward sharing across domains without a-priori knowledge of the format, structure etc.

The subsequent emergence of a number of value-added services across different domains therefore represents a basis for the technical evaluation of the project. Without VICINITY, there would be no common language for data exchange separate dictionaries would be needed between each pair of datasets being shared.

5.1.2. Cross-Domain Examples

The "VICINITY virtual Neighbourhood" concept allows IoT interoperability across domains to enable cross-domain services. Seamless and privacy-preserving data analysis for the creation of diverse cross-domain services will be based on various algorithmic techniques.

As an example, at the MPH Pilot Site, in the case of health domain, the VAS which provides analysis and clustering of elderly's people medical data to detect unusual behavioural events, is a cross-domain service. Smart monitoring would include several health condition measurements from health devices (blood pressure device and weight scale) but also from building sensors such as: motion sensors, door sensors and smart devices (oven and refrigerator). It is therefore important that such cross-domain examples are included in the evaluation and highlighted in the final report.

5.1.3. Technical Assessment-Ease of Use

VICINITY is designed to make joining its virtual neighbourhood as easy and straightforward as possible. The addition of a new user should not require major changes to the existing infrastructure. Instead he/she should be able to simply connect his/her devices to the VICINITY network by simply adding few, additional components. In order to integrate an infrastructure into the VICINITY virtual neighbourhood, only a few limited actions are necessary.

During the evaluation developers will be asked to give their opinion on the 'ease-of use'. The survey will be based upon the steps outlined here.

Essentially, three additional software components are necessary, two of which are available as open source projects:

- The VICINITY Open Gateway API (OGWAPI) (See https://github.com/vicinityh2020/vicinity-gateway-api)
- The VICINITY Agents local and remote (See https://github.com/vicinityh2020/vicinity-agent)
- An Adapter, connecting the available infrastructure to the VICINITY

These software components will be the subject of the Technical Evaluation and are shown in Figure 11 along with the information flow.

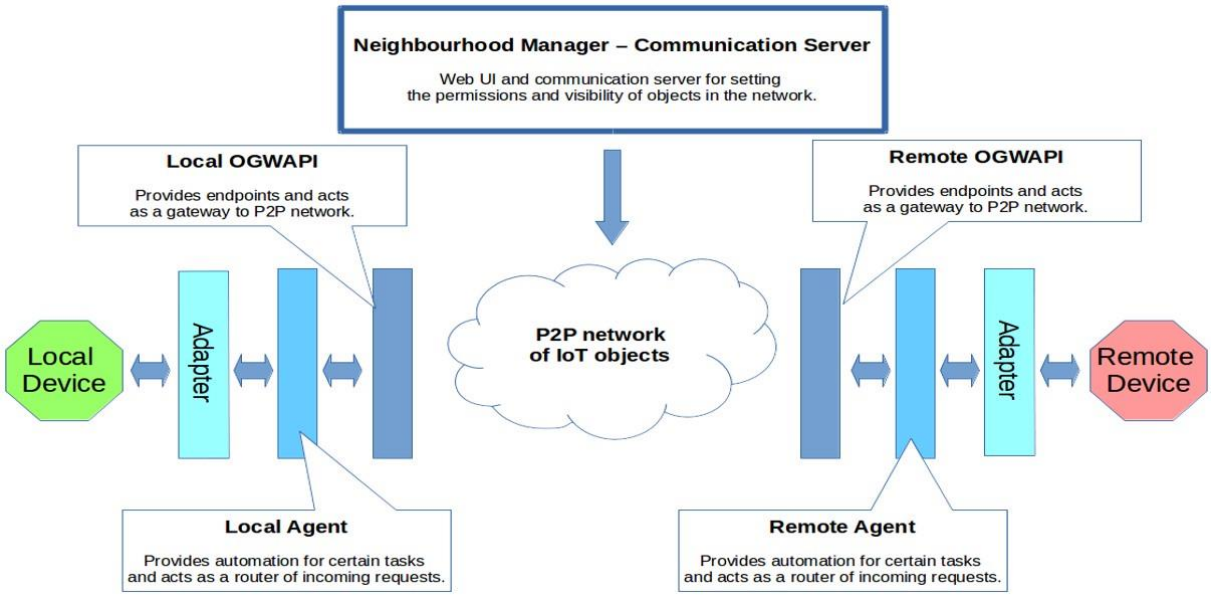

Figure 11 High-level VICINITY architecture overview

For the Open Gateway API and the VICINITY Agent, it simply comes down to “downloading and installing” these components from GitHub.

Both components are configured to work (almost) out-of-the-box. Only the agent will need login credentials, which can easily be acquired through the VICINITY neighbourhood manager: https://vicinity.bavenir.eu
Additionally, the Agent needs to be configured to contact the third component: The Adapter.

The adapter is, essentially the function that “translates” the communication inside the given infrastructure of the user into the VICINITY ontology and vice-versa. The VICINITY team has already implemented various adapters, which are again available open-source on GitHub: https://github.com/vicinityh2020/ How, and if, these adapters need to be configured is described in their respective documentations.

In summary, if a new user is relying on one of the Gateway Frameworks, for which an adapter was already implemented, joining the VICINITY neighbourhood is designed to be “plug-and-play”.

Developing an adapter for any new infrastructure is straightforward. A skilled programmer, familiar with designing RESTful APIs, should not have any serious problems on this task. The steps necessary are documented in more detail in the VICINITY Agent repository: https://github.com/vicinityh2020/vicinity-agent and previous VICINITY Deliverables from WP3 and WP4 [2].

The Open Calls provide a way of making a technical assessment of the ease-of-use of the VICINITY platform. New partners will join VICINITY and add new functionality over a period of six months. They are best-placed to give assessment of the ease-of-use for example, by questionnaires as described Section 4.

5.1.4. Business Development

The Business development evaluation of the VICINITY Platform will follow a step by step approach including:

- Definition of the Platform
- Development of the Platform
- Pilot and testing
- Continuous improvements

In order to better understand the business development of the VICINITY Platform, identification of potential clients is a key aspect. Stakeholders including SMEs, private and public entities are of great interest for the evaluation of the VICINITY Platform because of the additional business opportunities they may offer, such as innovative, value added services and applications in the field of any domain and their potential attractiveness for both individuals and corporate subscribers.

One of the most exposed concerns related to IoT is the breaching of privacy of personnel affected by IoT assets. To do this the VICINITY Platform facilitates a bottom-up ecosystem of decentralised interoperability of IoT infrastructures, where users can share the access to their smart objects without losing the control over them and having full privacy.

A further feature of the Platform is that it can connect IoT platforms, devices, end-users, cloud infrastructures and services in a fully interoperable and secure way offering manageability. This feature requires evaluation. Applications and services running in one Smart Infrastructure can access IoT objects and data streams connected to another Smart infrastructure, as part of its own infrastructure, if access is given.

The security context of VICINITY Solutions focuses on VICINITY Cloud components, security of VICINITY P2P Network and VICINITY Node components including VICINITY Communication Node, VICINITY Gateway API and VICINITY Agent.

The VICINITY architecture follows an interoperability approach whose main goal is to provide a standard way to both *Discover* and *Access* heterogeneous IoT objects distributed among sparse IoT infrastructures by employing a generic IoT ontology based on and extending existing standards. This enables the potential of interoperability among the users of the VICINITY Platform making it easy to use VICINITY Platform and to manage devices and users through VICINITY Platform interface. Stakeholders and organizations connecting to VICINITY via the Open Calls are exposed to the capabilities and potential of the VICINITY Platform. They will be in good position to evaluate the real value the Platform presents including its scalability, ease of adding new devices and Value-Added services to the platform through structured and clearly defined steps. The evaluation of the Open Calls is described in Section 7.

6. Pilot Trial Evaluation Task Plan Summaries

Note: The Gantt charts for the pilots, Tasks 8.2-8.5, are given in informative Appendices as they are subject to change.

6.1. WP8.32 Martim Longo, PO

The Martim Longo pilot site comprises three sets of use cases: Dynamic Building Audit and Smart School; UV for Citizens; and PV Plant Operations Management.

6.1.1. Dynamic Building Audit

The Dynamic Building Audit use case comprises overall Indoor Environment Quality (IEQ) and Energy Consumption. The Smart School use case is focused on a subset of IEQ parameters (Temperature, CO2, Humidity, Luminosity, Noise, Movement) relevant for the indoor areas used by the students.

The VAS user interface is implemented as a web application with a responsive layout which is usable in desktop and mobile browsers. It displays real-time sensor data, alert levels and historical sensor data for analytics.

The overall utility of the system developed to support this set of use cases, will ultimately be driven by the value of the information that facilitates the detection of inadequate IEQ or energy consumption conditions that may occur. Hence ENERC is taking a stakeholders' value co-creation approach to the VAS development that builds beyond simply connecting the devices to the VICINITY platform.

The evaluation will focus on the abnormal parameters detected during the trial period and on gathering feedback from site managers, school teachers and other stakeholders who are involved in the process and will be interviewed during various phases of the trial. Partial stakeholder feedback will be requested as part of each version deployment so that functionality increments can be iteratively assessed and requests for features can be backlogged for future evaluation. Stakeholders' feedback will be requested mid-trial as part of a major release cycle, so that modifications can be made before completion of the trial, according to the Gantt Chart shown in the Appendix (Section 12.2).

6.1.2. UV for Citizens use case

The UV for Citizens use case consists of an information service about current UV radiation and recommended precautions. The information service will be deployed as an additional *iframe* embeddable widget showing UV radiation and linking to a complimentary webpage with additional information (UV index, ambient temperature, humidity and practical recommendations), effectively reusing the IoT devices and IT infrastructure deployed at the demonstration site.

Stakeholders' feedback, including the editors of the websites that deploy the embeddable UV widget, will be surveyed mid-trial as part of a major release cycle, so that modifications can be made before completion of the trial.

6.1.3. PV Plant Operations Management

The *PV Plant Operations Management VAS* is responsible for combining data from different sensors and sources in order to evaluate and optimise planning of maintenance operations. By monitoring the meteorological conditions of the area, namely solar radiation and solar module production performance, the *PV Plant Operations Management VAS* will allow more accurate predictions and scheduling and managing of the related operations (personnel and equipment as well as the cycle of water purification) for actions like washing of the solar systems enabling usage optimization of resources and equipment.

Economic assessment of current and future maintenance costs and PV production efficiency will be estimated for evaluation purposes, although inter-annual variation of environmental factors such as precipitation and wind speed will probably not allow conclusive results; as PV production efficiency is highly correlated with prevailing dust accumulation conditions.

Stakeholders' feedback will be requested mid-trial as part of a major release cycle, so that modifications can be made before completion of the trial.

6.1.4. Business Evaluation

A number of business opportunities for ENERC will be explored during the trial as described in D9.12 *VICINITY Exploitation and Business Plan* [2] These will be evaluated during the trial from the perspective of possible further development and monetisation on completion of the VICINITY project.

The project primarily aims at creating viable solutions through "IEQ as a service" for schools. Improving the indoor environment quality of specifically identified school buildings, in order to improve the health and cognitive performance of their occupants, such as students and teachers. This objective is made possible through the continuous monitoring of indoor environmental quality parameters and intelligent analysis of data, coupled with effective methods of communicating these parameters to the users through variety of interfaces.

The implementation of these activities allows for more efficient resources management, such as energy, will allow for justified equipment upgrades and optimal space allocation for building use. It builds on the potential for the digitalisation of buildings as a means of monitoring and controlling environmental conditions, while driving an effective users' feedback-loop and joint value co-creation. The users of facilities would become active participants in managing as to how they use facilities and how they react to the interior conditions. Operations and maintenance effectiveness will be monitored and transparent not only to building managers, but also to the end users.

Energy, together with IEQ is an important part of building management. Energy costs in buildings accounts for around 30% of annual operating costs. It is estimated that a portion of such costs results from lack of integration of systems and inefficient equipment. In addition, reduction of energy use and improvement in occupants' comfort can be efficiently coupled. In this direction, the development of holistic tools enabling alternative management and control of building systems and occupants, through sensor data for building controls, has been requested by the sector. The coupling of the two creates cross-domain value and a first step in digitalization of the municipal building cluster and Solar Lab as a combined controlled environment.

Based on the descriptions above and set criteria the parameters below will be assessed:

Operations management

• Resource optimisation for each of the municipal cluster buildings

• Number of days the buildings operate under optimal IEQ conditions

• Number of outside of the boundaries events managed by the super users in the buildings

• Number of critical situations handled based on alarms

• Students comfort level satisfaction and level of engagement and understanding of how buildings work, including energy efficiency and resources consumption

• Building managers' ability to manage the buildings (overall satisfactions and effectiveness)

Resource Management

• Energy efficiency improvements

• Reduction in kW of highest monthly electricity peak and off peak

• Number of abnormalities in equipment functioning and performance discovered

• Money and resources saved on operation and maintenance of Concentrator Photovoltaic Panel cleaning at the solar park site.

• Operations Manager satisfaction (survey) of the solar park and maintenance personnel at the Solar Demonstration platform.

Parameters unquantifiable in the short-term

Long-term effects of modification of exposure to sun during high UV intensity periods to the most affected groups: children and elderly, linked to the school and to the elderly home.

New potential unlocked by reusing local sensor resources and cross-leveraging for secondary use. This approach is expected to pave the way to local to-local services creation within a shared economy context.

Other tools created

The team designed and developed a survey to assess the impact of the business models facilitated by the VICINITY Platform. The parameters used were adapted from the EU report *Cross-cutting business models for IoT* published in March 2018 [11].

6.2. WP8.3 Oslo Pilot Site, NO

The Oslo Pilot Site consist of two Use cases, 'Resource Management' and 'Predictive Operations'.

In Use Case *Resource Management,* TINYM is trialling and aiming to increase the efficiency in utility usage (for example electricity consumption) by regulating the consumption of individual devices at peak times to avoid excessive energy tariffs. This is tested by controlling the energy consumption of a GORENJE refrigerator and HVAC systems and guided by data and statistics collected with the backing of local partners.

The second Use case, *Predictive Operations* attempts to track the usage of washrooms, so cleaning personnel can more efficiently know when to clean; moreover, it provides statistics which can be used by building managers to reduce costs and for staff to demonstrate their value to their clients and management.

The evaluation will describe the viability of the individual VASs by comparing requirements from previous deliverables to the current running use case. TINYM is being assisted in evaluating the value of the room usage VAS by local partners who will be using the service. Utility data is collected with the help of local partners (IWMAC), providing statistics that can be referred to while the impact and method of regulating devices are fine-tuned over the lifetime of the project.

The value of the results will be analysed (as described in D 5.1 *Definition of Value-Added Services per Use Case*) by referencing figures (utility data) provided by IWMAC and other partners. The analysis will address the following areas:

Predictive Operation

• Number of cleaning operations avoided (as compared to previous regime)

• Number of waste removal operations avoided (as compared to previous regime)

• Number of unnecessary inspections avoided (compared to previous regime)

• Number of critical situations handled based on alarms

• Tenant satisfaction (toilet/meeting room cleanliness based upon surveys)

• Cleaning/waste removal team satisfaction (survey)

Resource Management

• Money saved on reduced load factor tariffs

• Reduction in kW of highest monthly electricity peak load

• Number of water leaks discovered

• Money saved on accurate tenant billing

• Time saved by avoiding manual meter readings

• Number of peak loads identified and alarmed by service

• Manager satisfaction (survey)

6.3. WP8.4 Tromsø, NO

Two use cases at the Tromsø Pilot Site have been identified. These are described in D5.1 along with the related VASs.

The first use-case is *Shared parking/priority parking*. In this use-case, the resident of an apartment may have a parking space which is temporarily vacant. The business opportunity is to make vacant parking spaces in apartments available via the internet to secondary users such as visitors.

The evaluation of the use cases will establish technical feasibility of the business benefit. The focus will be on gathering data, opinion (via questionnaires) and estimations based upon the KPIs defined in D5.1 for the VASs. The following examples are from the first use case and focus on the benefits:

- The area saved by sharing parking space instead of occupying more land
- The reduction of person-hours used for surveillance
- Effect on visitors and resident when parking space allocation is out of order
- What is the cost benefit of (investment vs. income/savings), what is the cost of installing the sensors, what financial gain is registered, and how do these values measure-up towards each other
- How much is spent on searching for vacant parking space
- How many tonnes CO2 (emission) are generated yearly when searching for vacant parking space
- How many person hours spent yearly searching for parking space

The second use case is entitled ‘eHealth Emergency parking’ and is dependent on the first one but has specific focus on managed healthcare apartments, and demonstrates how transport information and building data can be integrated with assisted living through agreements with car space owners and other stakeholders including the resident and healthcare workers. If a resident is detected as needing the assistance of a health worker, any available parking space will be allocated to the healthcare worker so that their time and money are not wasted finding parking elsewhere and the resident can benefit from a speedier visit.

The second use case includes a range of KPIs which provide data from which the overall benefits to society may be estimated. These include

- effect on emergency when parking space being out of order
- how many person surveillance hours have been saved
- how many lives can be saved because emergency vehicles may park and arrive in time

6.4. WP8.5 Pilea-Hortatis, GR

The MPH Pilot Site consists of two Use Cases, *eHealth and Assisted Living for elderly people at home* and *Health improvement for the middle-aged persons*.

6.4.1. Technical Assessment

Key Performance Indicators (KPI) demonstrate how effectively the VAS is achieving key business objectives and requirements that were first defined in *D1.3 Report on Pilot sites and Operational Requirements* and further analysed in *D5.1 VICINITY Value-Added Services definition, requirements and architectural design*.

To evaluate and validate the KPIs for the technical assessment, algorithms will be used to measure the values needed for the definition of the KPIs and real-time data acquisition for the evaluation dashboard. If some aspects of the intended functionalities specified cannot be delivered, it should be indicated in the report (D8.5) after the final deployment.

Key Performance Indicators for technical assessment for the Value-Added Services of the Pilot Site are presented in Table 7 below.

Use Case 1: *eHealth and Assisted Living for elderly people at home*	
Value-Added Services	**Key Performance Indicators (KPIs)**
Privacy-preserving Data Gathering and Storage. GDPR data auditing.	• Percentage of correct auditing of data transaction • Number of data requests
Analysis and clustering of elderly's people medical data to detect unusual behavioural events	• Average frequency of measurements per week/month. • Average usage of panic button per month •Number of false measurements automatically detected and rejected • Number of warning incidents
Triggering abnormal detection in homes	• Average percentage of false alarms per year (false positives) • Average percentage of successful identifications of abnormal situations (true positives) • Average percentage of abnormal notifications per month
Use Case 2: *Aggregated Statistical Analysis of data from wearables, medical devices, beacons*	
Value-Added Services	**Key Performance Indicators (KPIs)**
Privacy-preserving Data Gathering and Storage GDPR data auditing	• Same VAS as *Use Case 1*
Individual Statistical Analysis of data from wearables, medical devices, beacons	• Number of participations to the urban marathon • Percentage of citizens finishing the urban marathon/citizens initially signing up

Aggregated Statistical Analysis of data from wearables, medical devices, beacons	• Weight loss percentage for women and men in the Municipality • Number of citizens visiting specific gyms of the Municipality • Percentage of overweight men and women • Average number of daily steps per month achieved by participants and its variation during the urban marathon

Table 7 The Two KPIs for Technical Assessment of the two Use cases in the Pilea-Hortatis Pilot Site

During the mid-trial evaluation, identification of any problems will be implemented in order to fix them during the lifetime of the project. Data will be gathered autonomously through the IoT devices and gateways, integrated into the infrastructure and will be distributed to interested parties in a secure and private manner through the GDPR VAS deployed in MPH.

6.4.2. Business Assessment

Key Performance Indicators, KPIs, demonstrate how effectively the VAS is achieving key business objectives and requirements that were first defined in *D1.3 Report on Pilot sites and Operational Requirements* and further analysed in *D5.1 VICINITY Value-Added Services definition, requirements and architectural design*. To evaluate and validate the KPIs for the technical assessment, questionnaires will be distributed to collect opinions on the KPIs and autonomous data will be collected via the Value-Added Services.

Users of the first use-case are doctors and elderly people that will benefit from the service in financial and social ways: such as remotely checking whether the elderly citizens' health benefits lead to less costs for them. By creating typical user profiles and detecting abnormal conditions, unwanted events could be easily prevented and elderly people will feel safer living alone without the need to move to social care institutes. Doctors will benefit from the service as they can easily manage medical data from their patients in a mobile application and keep track of their progress in a comfortable and secure way. Municipalities also gain benefit as it is vital for them to promote disease prevention, improve management efficiency and minimise rehabilitation of older people. The VICINITY use case related to eHealth and assisted living can assist this issue and facilitate reduced expenditure for hospitals, health institutes and health care providers. The VASs derived from the use case could be distributed as a Software-as-a-Service distribution model and offer additional data analysis services based upon data collected to the municipality.

Regarding the second use case, middle-aged citizens will benefit from the Urban Marathon and will adopt new healthy habits through the competition that will result in preventing future health problems, leading to less primary institutional costs for health services. This service is valuable, not only to the citizens themselves, but also to the municipality, as it aims to reduce future health service costs. A new feature for the municipality is the web interface provided to them in order to keep track of citizens' progress and their health condition. The overall outcome of the VICINITY solution is expected to be presented to the regional government with the objective of considering this model for replication and further development to other municipalities.

At a larger scale beyond the municipality boundaries, similar competitions could be organized at a national level, or larger scale, so that municipalities compete each other. In addition to a healthier lifestyle for their citizens, municipalities could set targets for reduced long-term costs in terms of public health services, etc. thanks to the improved condition of their citizens.

User satisfaction is the primary aim of E-health evaluation. It is vital to find out how users value the product developed for them when other alternatives are also available. User-friendly evaluation includes cultural sensitivity and user needs [21]. The quality and quantity of information are two important aspects of evaluation of E-health products. User-feedback helps to determine which information needs to be included

as it is a primary source and which should be treated as less important or unnecessary. Questionnaires to the users that will exploit the services, such as doctors, will be distributed in order to identify any usability issues and changes recommended. Issues and problems that will probably arise will also be communicated throughout the Pilot lifetime to the Pilot partners responsible for the Greek Use Case. Users of these services will also exploit key value proposition of the platform meaning the interoperability, manageability and expendability of it, for example if they want to connect devices from different vendors or other platforms.

Standardization can enhance quality of evaluation studies and can create a higher degree of methodological uniformity among eHealth evaluation studies. Unfortunately, the current situation, as described in [22], is that eHealth evaluation frameworks are not used in empirical eHealth evaluations, standards are used insufficiently in the eHealth evaluation, and practitioners need more and better standards. To improve standards in this area, the European Commission issued the Standardisation Mandate M/403 EN and addressed it to the field of Information and Communication Technologies standardisation including CEN, CENELEC and ETSI [23].

Business assessment Key Performance Indicators for the Value-Added Services of the Pilot Site are presented in Table 8 below.

Use Case 1: *eHealth and Assisted Living for elderly people at home*	
Value-Added Services	**Key Performance Indicators (KPIs)**
Privacy-preserving Data Gathering and Storage ft. GDPR data auditing	• User satisfaction (regarding safety)
Analysis and clustering of elderly's people medical data to detect unusual behavioural events	•Number of patients actively participating with regular measurements/number of initial participants •Number of early problem detection per year •Patient / Health care provider satisfaction (through questionnaire) •Number of useful notifications (as considered by the health professional) •Elderly person's satisfaction
Triggering abnormal activity detection in homes	•Health professional satisfaction •Number of useful notifications (as considered by the health professional and/or guardian) •Elderly person's satisfaction.
Use Case 2: *Aggregated Statistical Analysis of data from wearables, medical devices, beacons*	
Value-Added Services	**Key Performance Indicators (KPIs)**
Privacy-preserving Data Gathering and Storage ft. GDPR data auditing	• Same VAS as *Use Case 1*
Individual Statistical Analysis of data from wearables, medical devices, beacons	• Number of patients actively participating with regular measurements/number of initial participants • Citizens/doctors' satisfaction (through questionnaire)

	• Percentage of citizens who decreased their weight/total number of overweight participants. (through questionnaire) • Percentage of citizens who increased their walking/running distance per month/ total number of participants. (through questionnaire)
Aggregated Statistical Analysis of data from wearables, medical devices, beacons	• Number of early problem detection per year in municipality citizens • Number of citizens that follow a healthier lifestyle in the specific municipality compared with other • Visits to sports centres compared with previous years (through questionnaire)

Table 8 The Two KPIs for the Business Assessment of the two Use cases in the Pilea-Hortatis Pilot Site

7. Evaluation results and lessons learned from the VICINITY open calls

The VICINITY open calls support the evaluation of VICINITY in terms of including additional information provided by the “very first external users” of the platform. The two open calls are focused on the following topics:

1. VICINITY first open call, IoT infrastructures. This open call will extend the integration scope of VICINITY.
2. VICINITY second open call, advanced value-added services. This open call will extend the business and technology scope of value-added services.

Therefore, the open call partners will interact with the VICINITY platform in order to create these extensions (technical and business related) and their experiences are considered as very valuable input for the overall evaluation of the project.

For Open Call 1 the required format needed for the mid-term and final reports is defined. This includes the evaluation aspect *"B.3 Lessons learned-Compare the results achieved against the objectives: clearly assess whether the objectives were met and describe the successes and lessons learned")*.

Open Call 2 will follow a similar structure, asking for mid-term and final reports.

The reporting periods for the open calls are defined as:

	Mid-Term Evaluation	Final Report
Open Call 1. IoT infrastructures	M37	M39
Open Call 2. Value-added services	M43	M46

Table 9 Reporting Periods for the Open Calls

Even though the nature of the two open calls is very different and more focused on one of the aspects of the evaluation (technical or business) it has been considered relevant to assign both open calls with all the evaluation aspects so they can provide feedback to the overall process. Each open call will focus in its own intrinsic evaluation area but both will report their results according to the following structure:

1. Technical assessment
2. Business assessment

The technical assessment will be, in accordance with the methodology described in this deliverable: implemented with the use of questionnaires and using the five-point Likert scale. In these questionnaires, different KPIs will be defined to assess the technical experience of the open call partners with the VICINITY platform. The users (the partners developing the open call projects) will list the VICINITY components used in their projects and will rate their experience in each of them.

The structure of the questionnaires will be something similar to this approach:

Technical evaluation

Questionnaire

Please identify the VICINITY components you have used to provide your application:

1. .....
2. .....

3. …..
4. …..
5. …..

Please replace the numbers with the VICINITY Components you have used and classify them.

1. Overall, how satisfied are you with the	1	2	3	4	5
Very satisfied					
Somewhat satisfied					
Neither satisfied nor unsatisfied					
Somewhat dissatisfied					
Very dissatisfied					

Table 10 Example Performance Questionnaire Template for the Open Calls

2. How adequate is the provided documentation for the	1	2	3	4	5
Extremely adequate					
Very adequate					
Somewhat adequate					
Not so adequate					
Not at all adequate					

Table 11 Example Performance Questionnaire Template for the Open Calls

The result will be reported in the deliverable D8.6 *Evaluation of user experience and performance of VICINITY Framework & value-added services*.

The business assessment is also part of the documentation defined in the open call and has been included in the Annex 2 of the contract (*B.4 Describe Impact that would enhance innovation capacity, create new market opportunities, strengthen competitiveness and growth of companies, or bring other important benefits for society, Potential for technical and commercial application, etc. Describe how the proposed extension has sufficient sustainable benefits for the VICINITY project)*.

Additionally, in this documentation the assessment of how VICINITY is contributing to their business development will be evaluated as follows.

Business evaluation

Please provide your evaluation of how VICINITY is contributing to your business.

- Identify and describe what aspects boost your business
- Identify and describe what aspects need improvement

The details of the evaluation will be further defined through the execution of the open calls and will be reported in the deliverable D8.6 *Evaluation of user experience and performance of VICINITY Framework & value-added services*. The future business plans will be reported in D9.14 *VICINITY exploitation and business plan, final version*.

8. Plans for Task 8.6 *Overall Evaluation of User Experience and Performance of VICINITY framework and tools*

Task 8.6 *Evaluation of user experience and performance of VICINITY Framework & value-added services* due on M48, is the deliverable of Task 8.6 at the end of the VICINITY Project. The Gantt Chart is in the Appendix (Section 12.5).

The associated deliverable, D8.6 due month 48 at the end of the project, will report on the results of the evaluation of user-experience and assess how well the VICINITY Framework performed against the expectations set up in this document. It will describe the way the overall system was evaluated, the evaluation criteria and the performance of each use case and application. This will include autonomously gathered data, results of questionnaires and evaluations of the economic and environmental performances. A rating system will be included to show the relative maturity of the use-case and the applications within it. The usefulness of the dashboard will also be assessed and reported including how performance indices may be updated over time so that year-on-year improvements can be measured and tracked.

It is required that the correct operation and effectiveness of the use-cases is demonstrated and that the value being created and delivered by that value-added service (VAS) is assessed. The maturity of the VASs as they increase during the pilot operation is also to be assessed. A key requirement is to understand the specific objective for VAS(s), so that they can be shown to be delivering the intended benefits. Much of the management data can be produced and processed automatically, but the confirmation of benefits actually being delivered is unlikely to be something that can be automated. Evidence can be gathered by a combination of:

- Making a subjective assessment by interviewing or polling users and stakeholders to capture their observations on the impact of the VICINITY VAS based upon their experience.
- Taking objective measurements of the system that is improved by the operation of the VICINITY VAS and comparing this to a “control” case. The control case could be a measurement of:
    - the same system before the VICINITY VAS is brought into service, or
    - a similar system that is almost identical to the system that is being assisted by the VICINITY VAS.
- In order to gather objective evidence, it is likely that the control case would need to operate with VICINITY sensors installed and reporting the status, but without interventions being made.

Objective measurements provide hard evidence of what is happening that can be used to understand any barriers or enablers affecting the value being delivered. The data should also help to understand the background to the subjective assessment of the impact of the VASs.

A rating system will be included to show the relative maturity of the use cases and the applications within it. The usefulness of the dashboard will also be assessed and reported including how performance indices may be updated over time so that year-on-year improvements can be measured and tracked.

It is proposed to gather the following information for each of the key Sensor types in each Pilot:

metric no	Attribute collected	Auto collection?	Information stored
1	Number of status messages received by the use-case app	Yes	Events so far today + historic total of events per day
2	Number of anomalous events reported / detected.	Yes	Events so far today + historic total of events per day
3	Number of events which could lead to an intervention being made	Yes	Events so far today + historic total of events per day
4	Number of cases where the intervention was confirmed to have been required. Interventions might include: sending a care worker to visit a person being monitored; or turning off a GORENJE freezer to reduce the peak power demand.	Manual	Events so far today + historic total of events per day
5	Number of interventions that were found to be necessary but were not initiated by VICINITY. An example might be where a care worker is called to attend a monitored person because a call from another person, rather than from a VICINITY alert.	Manual	Events so far today + historic total of events per day

Table 12 Attributes and Metrics for key Sensor Types in each Pilot

Note that metrics (1), (2) and (3) are to be gathered automatically but we need to ensure that each use case will output the required information. In some use cases the decision to make an intervention will be automatic. However, there may be an additional manual process that checks before an intervention is made. In which case there will need to be a way to report these decisions to the dashboard in real time.

Metrics (4) & (5) require that someone involved in delivering the pilot trial service report whether the requested intervention really was necessary, or for (5) whether an intervention was needed that VICINITY did not request. For example, if a care worker is sent to visit a person who is identified as needing an intervention, then the carer should record whether the visit was necessary or unnecessary. They should also record where interventions proved necessary, even when not requested by the VAS. Once again there needs to be an update sent automatically to the dashboard as soon as that report is made.

Metric no	Attribute to calculate	Auto calculation	Information stored
6	% of interventions made compared to anomalous case identification	Yes	% of (3) out of (2)
7	% of interventions confirmed to have been required, compared to the number made.	Yes	% of (4) out of (3)
8	% of un-predicted interventions compared to total interventions.	Yes	% of (5) out of ((5) + (4))

Table 13 Further Attributes and Metrics for key Sensor Types in each Pilot

Metrics (6), (7) and (8) will be generated automatically from the data that has been sent to the dashboard. These metrics give an assessment of the performance. They will be derived from previously stored information, so these metrics can be refined during or after the trial, as appropriate. This should form the basis for the automated VAS rating service that we have promised to deliver.

It is expected that the ratios in metric (6) and (7) will increase over time as the VAS is tuned to improve the effectiveness of the analysis process being carried out. Whilst metric (8) should remain close to zero.

The information above might be presented in a fairly simple way.

For metrics (1) to (5):

- Y axis: accumulated total
- X axis: time, with day-by-day steps

An example is given in Figure 6 above (page 27).

For metrics (6), (7) and (8) further work is needed on the presentation format when the task has started.

Details of what the VICINITY Usage Dashboard will track

The following tables are the first draft description of the information that will be tracked and used in the dashboard(s). Details will be reviewed by the Pilot technical lead person.

Tromsø Pilot

Metric no	Attribute collected	Car Sensor	Fridge Door	Other Sensor?
1	Number of status messages received by the use-case VAS	Report from car sensor	Door status	
2	Number of anomalous events reported / detected	Car has left / returned	Door open for more than threshold – local alarm	
3	Number of events which lead to an intervention being made	n/a	Care worker is sent to visit the person being monitored	
4	Number of cases where the intervention was confirmed to have been required	Empty car park space is assigned to car worker	Care worker reports that the visit was necessary	
5	Number of interventions that were found to be necessary but were not initiated by VICINITY	Care worker has to find somewhere else to park	Care worker is called to attend a monitored person because a call from another person, rather than from a VICINITY alert	

Table 14 The information that will be tracked and used in the dashboard for the Tromsø Pilot Site

OSLO Pilot

Metric no	Attribute collected	Door open sensor	Water consumption	Electricity consumption	Refrigerator
1	Number of status messages received by the use-case app	Door opening / closing	Regular meter reading	Regular meter reading	Reports temperature
2	Number of anomalous events reported / detected	n/a	n/a	n/a	n/a (door open alarm?)
3	Number of events which lead to an intervention being made	Usage threshold exceeded, cleaner sent	Usage threshold exceeded	Usage threshold exceeded	Temperature range exceeded?
4	Number of cases where the intervention was confirmed to have been required	Cleaner reports that no cleaning required	A notification is placed	A notification is placed	A notification is placed
5	Number of interventions that were found to be necessary but were not initiated by VICINITY	User asks for room to be cleaned			

Table 15 The information that will be tracked and used in the dashboard for the Oslo Pilot Site

Martim Longo

Metric no	Attribute collected	Temperature	CO2	UV	Power	Refrigerator
1	Number of status messages received by the use-case VAS	Room temperature readings (how often?)	CO2 levels (how often)	UV levels (how often)	Solar PV output	Temperature reading
2	Number of anomalous events reported / detected	N/A?	N/A?	N/A	No output warning?	N/A?
3	Number of events which lead to an intervention being made	What interventions?	What interventions?	What interventions?	turning off a GORENJE freezer to reduce the peak power demand	
4	Number of cases where the intervention was confirmed to have been required	??	??	??	??	??
5	Number of interventions that were found to be necessary but were not initiated by VICINITY	??	??	??	??	??

Table 16 The information that will be tracked and used in the dashboard for the Martim Longo Pilot Site

Pilea-Hortiatis

More data feeds need to be included in this table such as those from motion sensors and panic buttons. This work will be carried out by experts within VICINITY.

Metric no	Attribute collected	Wearable devices	Personal Medical data	Enquiries from relatives	Enquiries from health care professionals
1	Number of status messages received by the use-case app	Automatic upload	Push measurements sent by “elder”	Information requests.	Information requests.
2	Number of anomalous events reported / detected.		N/A?	n/a	n/a
3	Number of events which lead to an intervention being made	How well am I doing notification UI3.2.2	VAS3.1.3	n/a	n/a
4	Number of cases where the intervention was confirmed to have been required.			n/a	n/a
5	Number of interventions that were found to be necessary but were not initiated by VICINITY.		Care worker is called to attend a monitored person because a call from another person, rather than from a VICINITY alert.	n/a	n/a

Table 17 The information that will be tracked and used in the dashboard for the Oslo Pilot Site

Next Steps:

Production and collection of the data to be captured.

UNIKL have agreed to create and manage the Dashboard, but it will be for each pilot trail to arrange for the required data to be produced in real-time and sent to UNIKL. In order to do this, it is requested that each pilot identifies the following information for each of the parameters being monitored and presented on the dashboard:

Type of status update	Frequency of update	Frequency of statistical update sent to dashboard	Format of message sent to dashboard
Routine update (A)			
…. (more classes if appropriate).			
Anomalous alerts direct from sensor			
Anomalous status derived by the VAS based on sensor data			
Action instigated automatically by the VAS			
Action instigated by human intervention, based on VAS data			
Action instigated by other sources – not flagged by the VAS			
Perceived Usefulness of the intervention			

Table 18 Information for each of the parameters being monitored and presented on the dashboard per Pilot Site

With this information, UNIKL can start to design the data capture / input for the collection of statistical information from each use case. The creation of the dashboard Graphical User Interface can proceed in parallel.

Of course, there may be a need for harmonisation if each pilot site proposes to use a different approach to the creation and delivery of their statistical data. However, the first step is to ask each pilot site what statistical information can be produced easily so as to minimise the amount of work that needs to be done.

UNIKL will produce suggestions once there is more knowledge of the nature, quantity and diversity of the statistical information that is to be produced.

9. Evaluation Checklist

The following Checklist summarizes the key steps for evaluation which are described in this report and are required to make a VICINITY evaluation by the Pilot Site Evaluator or VICINITY Platform Evaluator. This checklist is to be used in conjunction with the Gantt Charts in the Appendix. This will prompt the evaluator to survey dimensions which may go beyond the VAS KPIs which were first identified in D5.1.

Evaluation Step	Section	Y/N
Appoint a person to be responsible for evaluation and 'run' the Task Gantt chart	Appendix	
Train a person(s) to manage and run surveys, especially if EUSurvey is chosen	4.2	
Identify key stakeholders for surveys: users, service provider, infrastructure owners, site managers.	6,	
Technical evaluation. Results of laboratory testing and 'hackathons' and key standards added to the Evaluation Spreadsheet.	2.4	
Review the KPIs. Are they measurable? How will the data be gathered? Are sufficient dimensions identified for the Task, as in the Project Objectives?	6, 2.1, 4, 1.4	
Technical evaluation- by service provider. Are the IoT devices and gateways working correctly? How well? To what extent is 'interoperability as a service' achieved cross domain? Are the standards adequate for wide-scale deployment?	2.4,5.1.2	
Technical evaluation. Are events being logged and anomalies being logged and sent to the evaluation dashboard? How many per day/week?	2.4, 8	
Technical evaluation. Is the battery management/replacement process working?	Table 5	
Technical Evaluation. Does the Evaluation Dashboard give benefit for consolidation of results or showcasing? Have you a better local Evaluation Dashboard?	4.1	
Technical evaluation. How well are security and privacy requirements being met?	3.3	
Technical evaluation. Are any fixes required resulting from the mid-trial evaluation?	3.1.2	
Technical and business evaluation. How scalable is the solution?	1.2	
Carry out user/stakeholder satisfaction surveys. Are the users' unmet needs being satisfied and are they satisfied with the performance of VICINITY?	2.5, 3.1.1 5.1.1	
Business assessment. Does VICINITY add value (when comparing the 'with' and 'without' scenarios?). Did any unexpected benefits/demerits come from the trial?	2.1.1, 3.1.1, 5.1.1	
Business assessment. Does the solution justify further investment?	2.5, 6	
Consolidate the results of the technical and business assessments, add them to the evaluation spreadsheet and prepare graphical visualisations, e.g. Figure 4	2.3	
Strategic benefit. How well does the VICINITY solution match the neighbourhood, citywide, regional and/or EU requirements?	2.2	
Prepare Reports to stakeholders including VICINITY Deliverables	6	

Table 19 Evaluation Checklist

10. Conclusions

This report has presented the steps needed to satisfy Milestone 9 of the VICINITY Project *Pilot demonstration and overall system evaluation* at the end of the project, Month 48 December 2019.

A review of relevant standards and other publications was carried out to discover what methodologies have already been developed for IoT and which could be used to evaluate VICINITY. The ISO standards reviewed were only applicable to a single aspect such as security or a single domain and were too heavyweight for a R&I project such as VICINITY. The ITU Recommendations offered possible KPIs, but did not offer an evaluation methodology. The evaluation methodology chosen is based upon the principles of the European Telecommunications Standards Institute (ETSI) Standard TS 103 463 V1.1.1 (2017-07) *Key Performance Indicators for Sustainable Digital Multiservice Cities*. Although it is not specifically targeted at neighbourhoods, it covers multiple domains and provides guidelines such as how the five-point Likert scale is used in posing questions for stakeholder surveys. By using this standard, comparisons can be made in future years and the results can be included in city-wide surveys without the need to revisit results. The reviews will be carried out by members of the pilots. They will draw upon autonomously gathered data from devices in the trials and reviews with users and other stakeholders.

Data will be collected autonomously for display on the evaluation dashboard. In the experimental set- up, metadata, such as number of events per day, is recorded and how many of these led to true or false alarms. The usefulness of the evaluation dashboard, in providing beneficial data to stakeholders or for showcasing will be assessed during the final year of the project.

The four pilots operate in different domains: assisted living, wellbeing, buildings management, and energy management. Each has presented details of how they will carry out their evaluations based upon their key performance indicators. All use the VICINITY platform to set-up point-to-point connections to allow data sharing between devices connected to their gateways and are seek to add novel and opportunistic Value-Added Services over the top of the infrastructure.

An evaluation checklist has been provided summarizing the key steps for evaluation which are described in this report and are required to make a VICINITY evaluation by the Pilot Site Evaluator or VICINITY Platform Evaluator. This will prompt the evaluator to survey dimensions which may go beyond the VAS KPIs which were first identified in D5.1.

The performance of the VICINITY platform, its nerve centre, will also be evaluated. It was necessary to define additional dimensions to the key performance indicators for this evaluation.

VICINITY offers a platform on which a wide range of unmet needs can be met via the Value-Added Services it supports. The evaluation of these from both technical and stakeholder perspectives will lead to business propositions which can be carried forward after the project ends and will be presented in D9.14 *VICINITY exploitation and business plan, final version* at the end of the project.

Open Calls, both the first and second, from VICINITY have been designed to allow new organisations to join the project to test-out new opportunistic infrastructures and Value-Added Services. These will be evaluated in Work Package 8 and their future business plans will be reported in D9.14.

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12. APPENDICES

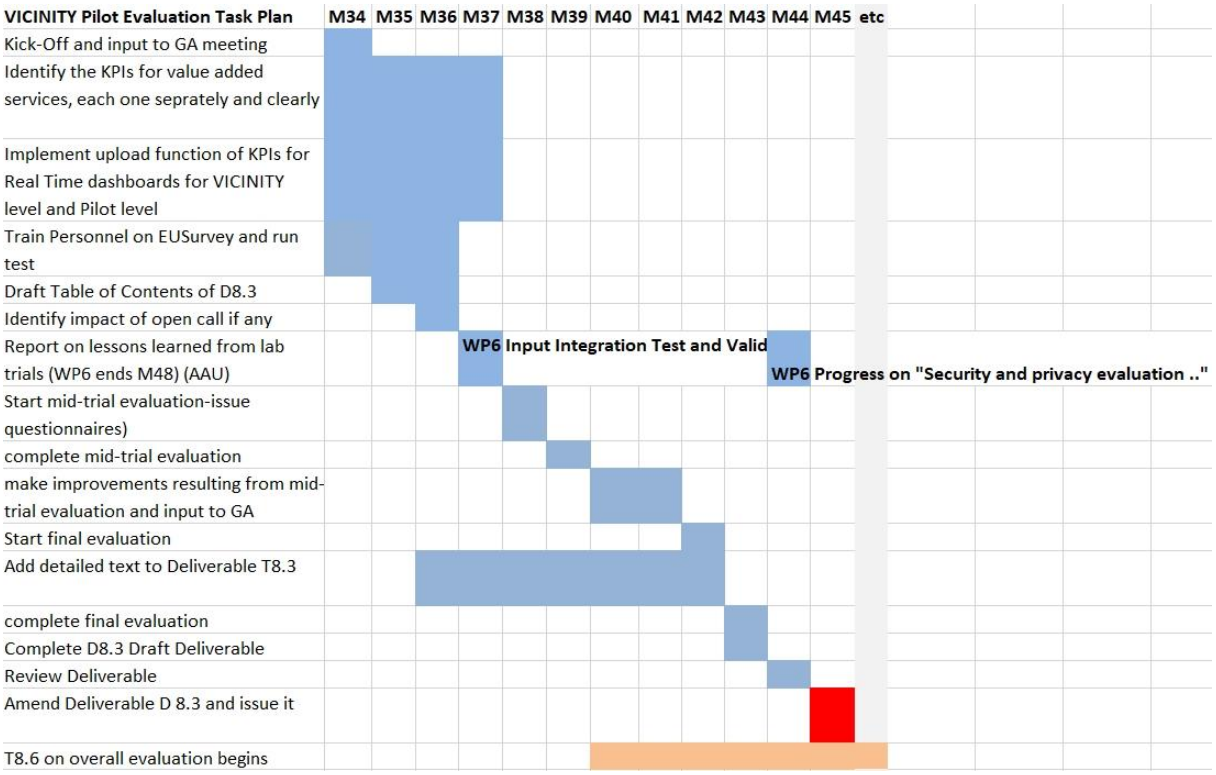
12.1. Gantt chart for VICINITY Dashboard

VICINITY Dashboard Task Plan	M34	M35	M36	M37	M38	M39	M40	M41	M42	M43	M44	M45	etc
Requirements capture													
Measurement metrics defined													
Prototype development													
First prototype ready			x										
Integration of Dashboard Reporting into													
UI Improvements / Bug fixing													...
Dashboard goes live					x								

12.2. Gantt chart for Task 8.2 Realisation and Evaluation of Neighbourhood GRID Ecosystem (Martim Longo)

VICINITY Pilot Evaluation Task Plan	Oct18	Nov18	Dec18	M37	M38	M39	M40	M41	M42	M43	M44	M45	etc	
Kick-Off and input to GA meeting														
Identify the KPIs for value added services, each one seprately and clearly														
Implement upload function of KPIs for Real Time dashboards for VICINITY level and Pilot level														
Train Personnel on EUSurvey and run test														
Receive inputs from the stakeholder relating to the demo sites and VAS apllications														
Draft Table of Contents of D8.x														
Identify impact of open call if any														
Report on lessons learned from lab trials (WP6 ends M48) (AAU)				WP6 Input Integration Test and Validation							WP6 Progress on "Security and privacy evaluation .."			ENERC does not have MM allocated to WP6
Start mid-trial evaluation-issue questionnaires)														
complete mid-trial evaluation														
make improvements resulting from mid-trial evaluation and input to GA														
Start final evaluation														
Add detailed text to Deliverable T8.x														
complete final evaluation														
Complete D8.1 Draft Deliverable														
Review Deliverable														
Amend Deliverable and issue it														
T8.6 on overall evaluation begins														

12.3. Gantt chart for Task 8.3 Realisation and Evaluation of Buildings and for Assisted Living Neighbourhood (Oslo Science Park)



12.4. Gantt chart for Task 8.4 Realisation of, and Evaluation of, Intelligent Transport and Parking Use Case (Tromsø)

12.5. Gantt chart for Task 8.5 Realisation of eHealth at Home Use Case (Pilea-Hortatis)

12.6. Gantt chart for Task 8.6 Overall Evaluation of User Experience of VICINITY Framework and Tools

		M37	M38	M39	M40	M41	M42	M43	M44	M45	M46	M47	M48
	preparation- detailed plans, report template etc												
	completion of Dashboard (not pat of T8.6)												
	Kick-off meeting												
each pilot	prove out dashboard												
each pilot	establish "control" measures												
each pilot	gather data on trial via dashboard												
each pilot	gather stakeholder views on Pilot												
each pilot	Analyse dashboard trends												
each pilot	Interim evaluation prior to making improvements												
each pilot	D8.6 drafting												
	D8.6 review												