COP-PILOT's Unified Methodology for Project Validation and Evaluation

DEFINITION AND EVALUATION OF PROJECT-WIDE (WP1-WP7) KEY PERFORMANCE AND VALUE INDICATORS

D0.1: COP-PILOT's Unified Methodology for Project Validation and Evaluation

Reports on a project-wide methodology to validate and evaluate every aspect of COP-PILOT

Work packages	WP1-WP7
Tasks	WP1-WP7 tasks
Due date	**First deadline: 30/06/2026 (covers D5.1, D6.1, D7.1, D7.2, and D7.5)** Second deadline: 31/03/2027 (covers D6.2) Third deadline: 31/12/2027 (covers D5.2, D6.3, D7.3, and D7.4)
Submission date	**First version (v1): 02/07/2026 (covers D5.1, D6.1, D7.1, D7.2, and D7.5)** Second version (v2): 31/03/2027 (covers D6.2) Third version (v3): 31/12/2027 (covers D5.2, D6.3, D7.3, and D7.4)
Deliverable lead	UBITECH (Technical Coordinator and WP3 leader)
Version	**1.0**
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Reviewers	NETC, ONE, NOVA, D4P, INC, TID, UBI
Abstract	Having a unified strategy to evaluate every aspect of a large project facilitates target audience to grasp both the scale of the project, but also the amount of work being put together to homogeneously address challenges that typically exceed finite work package or task limits. To this end, this document defines what Key Performance Indicators (KPIs) and Key Value Indicators (KVIs) mean for COP-PILOT and proposes a unified validation and evaluation strategy for every KPI and KVI, across three (3) validation rounds (M17, M25, M33) defined in the COP-PILOT Grant Agreement. To this end, the consortium homogeneously coordinates and addresses various performance and value indicators, ranging from deep technical, to business, and multi-fold impact in a cross-WP manner.
Keywords	KPI, KVI, methodology, validation, evaluation, impact, standardization, communication, dissemination.

Document Revision History

Version	Date	Description of change	List of contributors
V0.1	18/01/2026	Table of Contents	*Georgios P. Katsikas (UBI)*
V0.2	20/03/2026	First complete version delivered to all WP leaders and Cluster leaders.	Georgios P. Katsikas (UBI)
V0.3	24/04/2026	First round of inputs by Clusters	*Cluster 1: Martin Engelmark (LTUB)* *Cluster 2: Nuria Molner (UPV),* *Cluster 3A: Gregory Mygdakos (AGA)* *Cluster 3E: Lefteris Mylonas (UOP)* *Cluster 4: Luis Rosa (ONE)*
V0.4	25/05/2026	Final round of inputs by platform component owners and Clusters	Kostis Trantzas (UOP), Christos Tranoris (PNET), Philip Griffiths (TATA), Konstantinos Fragkos (NETC), Benjamin Ertl (AGE), Georgios P. Katsikas (UBI),
V0.5		Final round of inputs by Clusters	*Cluster 1: Martin Engelmark (LTUB)* *Cluster 2: Nuria Molner (UPV),* *Cluster 3A: Gregory Mygdakos (AGA)* *Cluster 3E: Lefteris Mylonas (UOP)* *Cluster 4: Luis Rosa (ONE), Jaime Ruiz (NOKIA)*
V0.6	20/06/2026	Final editing of the first version	Georgios P. Katsikas (UBI)
V1.0	**02/07/2026**	**Version v1.0 submitted and linked with D5.1, D6.1, D7.1, D7.2, and D7.5**	**Georgios P. Katsikas (UBI), Ioanna Drigkopoulou (NETC)**
V2.0	27/02/2027	Version v2.0 to be submitted and linked with D6.2	N/A
V3.0	31/12/2027	Version v3.0 to be submitted and linked with D5.2, D6.3, D7.3, and D7.4	N/A

Grant Agreement No: 101189819 | **Topic:** HORIZON-CL4-2024-DATA-01-03
Call: HORIZON-CL4-2024-DATA-01 | **Type of action:** HORIZON-IA

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Co-funded by the European Union

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
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Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

Co-funded by the European Union (COP-PILOT, 101189819). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them. This work has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).

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Project Co-funded by the European Commission in the Horizon Europe Programme		
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Dissemination Level		
PU	Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page)	X
Classified R-UE/ EU-R	EU RESTRICTED under the Commission Decision No2015/ 444	
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* R: Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

DATA: Data sets, microdata, etc.

DMP: Data management plan

ETHICS: Deliverables related to ethics issues.

SECURITY: Deliverables related to security issues

OTHER: Software, technical diagram, algorithms, models, etc.

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Acronyms and Abbreviations

Term	Description
3GPP	3rd Generation Partnership Project
5G	Fifth Generation
ATSI	AgriTech Transformation and Sustainability Initiative
AUT	Automation
CIM	Context Information Management
DORA	Digital Operational Resilience Act
EIOPA	European Insurance and Occupational Pensions Authority
ETSI	European Telecommunications Standards Institute
FRA	Fragmentation
GPO	Global Project Objectives
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
KPI	Key Performance Indicator
KVI	Key Value Indicator
NAP	Network Availability and Performance
NIST	National Institute of Standards and Technology
PIS	Piloting Infrastructure Scale
SDG	Sustainable Development Goal
SEC	Security
TMF	TM Forum
VSA	Vertical Sector-Agnostic

1 A Holistic Methodology for the COP-PILOT Evaluation

This document provides a holistic view around the validation and evaluation methodology of the COP-PILOT project. This methodology is based on two main pillars. First, COP-PILOT introduces a project-wide KPI definition strategy (see Section 1.1), based on which we formally describe every KPI irrespectively of its type (i.e., technical, dissemination, communication, etc.). Secondly, once every project KPI is defined, COP-PILOT introduces another formal notation to evaluate KPIs in a similar homogeneous way (see Section 1.3).

1.1 Template to define a COP-PILOT KPI

Every COP-PILOT KPI is defined based on the template shown in Table 1-1. According to this table, the mandatory attributes to define a KPI are (i) a unique KPI ID, (ii) a name, (iii) a short description, and (iv) a reference stating the source of this definition (i.e., the literature and/or a specific project document).

Table 1-1: Template table defining a COP-PILOT KPI.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
A unique KPI identifier	A name for this KPI	A descriptive summary of this KPI	A standard definition of this KPI originating from the bibliography and/or the COP-PILOT Grant Agreement [1].

Section 2 defines all COP-PILOT KPIs based on the template shown in Table 1-1.

1.2 Template to define a COP-PILOT KVI

Every COP-PILOT KVI is defined based on the template shown in Table 1-2. According to this table, the mandatory attributes to define a KVI are (i) a unique KVI ID, (ii) a name, (iii) a key value related to this KVI, and (iv) n associated list of measurable indicators.

Table 1-2: Template table defining a COP-PILOT KVI.

KVI ID	KVI Name	Key Value related to a KVI	Associated Measurable Indicators
A unique KVI identifier	A name for this KVI	What is the value produced out of a KVI	Measurable indicators that contribute to the key value. Those indicators could be either (i) KPIs defined by the project (as per Table 1-1) OR (ii) other measurable metrics defined by a relevant business stakeholder.

1.3 Template to evaluate all COP-PILOT KPIs and KVIs

Subsequently, Table 1-3 is used as a general template to keep track of the evaluation of every COP-PILOT KPI/KVI across the three (3) evaluation phases of the project. According to the Grant Agreement [1], these phases span between M17 and M33. By M17 the initial evaluation phase should be concluded, the results of which are reported in the mid-term (M18) deliverables (i.e., D5.1 [2], D6.1 [4], D7.1 [5], and D7.2 [6]). An intermediate evaluation phase follows between M18 and M25; D6.2 [7] will report on findings during this intermediate evaluation, while D0.1 will document the findings by M27. Then, the final evaluation phase takes place between M26 and M33. The reporting for the final evaluation phase will be done at the end of the second reporting period (i.e., M36) through deliverables D5.2 [8], D6.3 [9], D7.3 [10], and D7.4 [11] as well as D0.1. Note that this template holds for KPIs/KVIs that can be measured during the COP-PILOT timeline. There are other types of long-term KPIs/KVIs which should be evaluated beyond the duration of the project (e.g., 1-5 years past COP-PILOT); for these KPIs/KVIs we have a dedicated template in the next section.

Table 1-3: Common template table for the evaluation of a COP-PILOT KPI/KVI.

<table>
<tr><th colspan="6">KPI/KVI across project evaluation phases</th></tr>
<tr><td>Baseline Value (M1)</td><td>Measured Value – Initial Evaluation (M17)</td><td>Measured Value – Intermediate Evaluation (M25)</td><td>Measured Value – Final Evaluation (M33)</td><td>Target Value (M36)</td><td>Assessment Result</td></tr>
<tr><td>KPI/KVI value at the beginning of the project (i.e., Before COP-PILOT)</td><td>KPI/KVI value measured after COP-PILOT is employed at an early stage</td><td>KPI/KVI value measured after COP-PILOT is employed at an intermediate stage</td><td>KPI/KVI value measured after COP-PILOT is fully employed</td><td>Target value of this KPI/KVI. This value is set from the beginning and should provide the delta of COP-PILOT with regards to the initial value (M1)</td><td>ACHIEVED if the value measured during the final evaluation meets or exceeds the target value
NOT ACHIEVED if the value measured during the final evaluation does not meet or exceed the target value</td></tr>
<tr><th colspan="6">KPI/KVI Methodology</th></tr>
<tr><td colspan="2">Measurement Calculation Formula</td><td>Measurement Input Source</td><td colspan="2">Measurement Collection Process</td><td>Measurement Collection Frequency</td></tr>
<tr><td colspan="2">A formal mathematical formula to calculate the value of this KPI/KVI</td><td>A brief statement on the inputs of this KPI/KVI</td><td colspan="2">A brief statement of the way the KPI/KVI values will be collected</td><td>A brief statement on the frequency of the collection process. Some KPIs/KVIs may require periodic assessment while others not.</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><td colspan="3">Identified Risk(s)</td><td colspan="3">Risk Mitigation Plan</td></tr>
</table>

Potential risks that may impact the fate of a KPI/KVI	Potential contingency plans to work around emerging risks

1.4 Template for long-term KPIs/KVIs post the COP-PILOT project duration

Some KPIs/KVIs refer to post-project evaluation, either in the mid-term (i.e., 1-2 years after COP-PILOT) or long-term (i.e., 3-5 years after COP-PILOT). For these KPIs, no actual measurements can be provided during the initial and intermediate evaluation cycles, therefore we defined a dedicated template to capture their impact beyond COP-PILOT as shown in Table 1-4.

Table 1-4: Common template table for the evaluation of post COP-PILOT duration KPI/KVIs.

KPI/KVI across project evaluation phases			
Achieved Value on M36	**Target Value (X years after the end of the project)**		**Assessment Result**
KPI/KVI value at the end of the project	Desired target value of this KPI/KVI X years after the end of the project		ACHIEVED if the value measured during the final evaluation **meets or exceeds the target value** NOT ACHIEVED if the value measured during the final evaluation **does not meet or exceed the target value**
KPI/KVI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
A formal mathematical formula to calculate the value of this KPI/KVI	A brief statement on the inputs of this KPI/KVI	A brief statement of the way the KPI/KVI values will be collected	A brief statement on the frequency of the collection process. Some KPIs/KVIs may require periodic assessment while others not.
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Potential risks that may impact the fate of a KPI/KVI		Potential contingency plans to work around emerging risks	

Section 3 uses the templates shown in Table 1-3 and Table 1-4 to evaluate all KPIs/KVIs defined in Section 2.

1.5 Summary

As shown in the rest of this document, COP-PILOT's thorough validation and evaluation methodology spans **across 12 different categories** of indicators outlined both in Section 2 (definition of indicators) and Section 3 (evaluation of these indicators). This broad range of categories results in the definition and systematic evaluation of **more than 300 KPIs/KVIs.** All these KPIs/KVIs will be evaluated across one or multiple phases as already are described in Section 1.3 (3-phase evaluation) and Section 1.4 (1-phase evaluation). This deliverable shows the commitment of the COP-PILOT project to deliver great results and become an exemplar project in the European landscape.

2 Definition of COP-PILOT KPIs and KVIs

This section provides a holistic view around the validation and evaluation methodology of the COP-PILOT project. This methodology suggests looking COP-PILOT from different angles:

- a broad angle where global (project-wide) objectives are mapped to quantitative KPIs (Section 2.1). These indicators appeared in Section 1 of the project proposal and establish a foundation for the evaluation of the project. We revisit these indicators here as part of much broader evaluation during the runtime of the project.
- a cluster-agnostic angle where the COP-PILOT platform's impact is quantified against any business sector (i.e., cluster) (Section 2.2).
- a cluster-specific angle where each business sector (i.e., cluster) in COP-PILOT defines its own business performance indicators and values (Section 2.3).
- an overall impact perspective through a set of orthogonal KPIs addressing impact on:
    - Scientific Community (Section 2.4),
    - Economy (Section 2.5),
    - Technology (Section 2.6),
    - Society (Section 2.7),
    - Standardization (Section 2.8),
    - Communication (Section 2.9),
    - Dissemination (Section 0),
    - Exploitation (Section 2.11), and
    - Sustainability (Section 2.12).

2.1 Definition of KPIs related to Global Project Objectives

In this section we introduce the KPIs promised in the Description of Work of the COP-PILOT project. These KPIs address performance targets across 7 categories, each mapped to a corresponding COP-PILOT project objective. To identify these KPIs, we refer to them as Global Project Objective KPIs, abbreviated with the prefix KPI-GO, followed by the objective and sub-objective numbers.

2.1.1 KPIs related to Global Project Objective 1 (Orchestration-related)

Table 2-1 lists the KPIs related to Global Project Objective 1 as per the COP-PILOT Grant Agreement document.

Table 2-1: KPIs related to Project Objective 1 (Orchestration-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-1.1a	Platform integration with Infrastructure controllers	Integration with infrastructure controllers (e.g., Kubernetes, ETSI TeraFlowSDN, Open5Gs)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.1b	Platform integration with NFVO	Integration with NFV Orchestrator (e.g., ETSI OSM)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.1c	Platform integration with IoT platforms	Integration with open IoT platform (e.g., FIWARE, Arrowhead) based on ETSI NGSI-LD	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.2a	Standard interfaces support	Programmable integration fabric with support for standardized interfaces, i.e., TMF, GSMA GST/NEST, and IETF	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.2b	Telemetry APIs support	Programmable integration fabric with support for > 3 open telemetry APIs (e.g., OpenTelemetry, IETF In-situ, and P4.org)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.3	Number of exposed service & resource APIs	Expose full stack service & resource APIs to various stakeholders, including onboarding, ordering, services and resources lifecycle management, real-time policy management, real-time telemetry, and zero-touch domain expansion, rendering COP-PILOT a multi-faceted platform hub	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.4	Orchestration complexity	Orchestration complexity by means of number of orchestration instances across all Clusters ≥10	KPI introduced in the COP-PILOT Grant Agreement document

KPI-GO-1.5	Response time for application-level reconfiguration at the edge	Application-level reconfiguration at extreme edge nodes	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.6a	Response time for compute infrastructure reconfiguration	Compute infrastructure reconfiguration at edge/core nodes	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-1.6b	Response time for network infrastructure reconfiguration	Network infrastructure reconfiguration (e.g., offloading, migration) at edge/core nodes	KPI introduced in the COP-PILOT Grant Agreement document

2.1.2 KPIs related to Global Project Objective 2 (Service-related)

Table 2-2 lists the KPIs related to Global Project Objective 2 as per the COP-PILOT Grant Agreement document.

Table 2-2: KPIs related to Project Objective 2 (Stakeholder service-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-2.1a	LLM impact on service ordering time	COP-PILOT LLM-UI to reduce ordering time	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.1b	LLM impact on policy provisioning time	COP-PILOT LLM-UI to reduce policy provisioning	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.2	Number of SLA violation forecasting schemes	Deployment and evaluation of smart SLA violation forecasting schemes, including comparative studies on their performance vs. accuracy	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.3	SLA preservation time	Reduce total SLA preservation time (incl. SLA violation forecasting and service reconfiguration for SLA assurance)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.4	Eliminate human factors in SLA preservation	Eliminate human intervention in SLA preservation (impossible with today's automation capabilities)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.5	Amount of integrated Intelligence	Integrated intelligence by means of (i) LLM-based user intent to service blueprint generation and (ii) SLA forecasting ability – into edge/core cloud domains	KPI introduced in the COP-PILOT Grant Agreement document

KPI-GO-2.6a	SLA violation prediction MAPE	SLA violation prediction Mean Absolute Percentage Error	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.6b	SLA violation prediction precision	SLA violation precision and recall	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-2.7	Time buffer for timely prediction enforcement	Anticipatory prediction, followed by timely service and/or network reconfiguration to avoid fatal degradation of the supported services	KPI introduced in the COP-PILOT Grant Agreement document

2.1.3 KPIs related to Global Project Objective 3 (Infrastructure-related)

Table 2-3 lists the KPIs related to Global Project Objective 3 as per the COP-PILOT Grant Agreement document.

Table 2-3: KPIs related to Project Objective 3 (Stakeholder infrastructure-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-3.1	Domain expansion time	Reduce time to expand to a new domain from hours to < 5 min (depending on initial user inputs to the COP-PILOT UI, i.e., One-Touch Domain Expansion)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-3.2	Platform instance provisioning	Time to provision a fresh COP-PILOT platform instance (including time to integrate with domain's legacy IoT platform) < 75 sec	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-3.3	Domain data exposure time	Time to expose domain data management services through the integration fabric < 1 hour	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-3.4	IoT device cardinality	Secure integration of at least 200 IoT devices across the piloting clusters	KPI introduced in the COP-PILOT Grant Agreement document

2.1.4 KPIs related to Global Project Objective 4 (Cluster-related)

Table 2-4 lists the KPIs related to Global Project Objective 4 as per the COP-PILOT Grant Agreement document.

Table 2-4: KPIs related to Project Objective 4 (Cluster-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-4.1	Clusters cardinality	4 large scale piloting clusters targeting use cases in manufacturing, smart buildings, agriculture, energy, mobility, and logistics sectors	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-4.2	Cluster sites cardinality	Interconnection and established interoperability with >20 cluster sites from project's UCs and >10 additional sites from involved 3rd parties	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-4.3	Number of unique service blueprints'	Extraction of deployment blueprints for at least 5 different scenarios per targeted sector as defined in KPI-GO-4.1	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-4.4	Service blueprints' application range	Use of KPI-GO-4.3 blueprints in at least 3 different 3rd party deployment scenarios per piloting cluster	KPI introduced in the COP-PILOT Grant Agreement document

2.1.5 KPIs related to Global Project Objective 5 (Pilot-related)

Table 2-5 lists the KPIs related to Global Project Objective 5 as per the COP-PILOT Grant Agreement document.

Table 2-5: KPIs related to Project Objective 5 (Pilot-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-5.1a	Unique application components' cardinality (from UCs)	Collection of > 40 application micro-services from project's use cases out of which at least 50% are open	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-5.1b	Unique application components' cardinality (from Open Calls)	Collection of > 20 additional micro-services from 3rd parties out of which at least 50% are open	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-5.2	Platform service components' cardinality	Development and adaptation of > 15 platform services in the areas of intelligent resource management, automation and security, all of which are open	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-5.3	Datasets' cardinality (UCs and Open Calls)	Collection of >20 measurement and validation datasets from project' and 3rd party's UCs	KPI introduced in the COP-PILOT Grant Agreement document

2.1.6 KPIs related to Global Project Objective 6 (Market-related)

Table 2-6 lists the KPIs related to Global Project Objective 6 as per the COP-PILOT Grant Agreement document.

Table 2-6: KPIs related to Project Objective 6 (Market-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-6.1	Market analyses' cardinality	Market analysis for 4 sectors (Industry, Energy, Smart City/Building, Agriculture) according to sector needs and offered platform capabilities	KPI introduced in the COP-PILOT Grant Agreement document
KPI-GO-6.2	Number of business cases defined	Extraction >10 business cases linked to offered application and services per sector	KPI introduced in the COP-PILOT Grant Agreement document

2.1.7 KPIs related to Global Project Objective 7 (Impact-related)

Table 2-7 lists the KPIs related to Global Project Objective 7 as per the COP-PILOT Grant Agreement document.

Table 2-7: KPIs related to Project Objective 7 (Impact-related).

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-GO-7.1	Number of 3rd party submissions for integration	Achieve > 80 submissions for 3rd party piloting use case integration and validation in COP-PILOT	KPI introduced in the COP-PILOT Grant Agreement document

2.2 Definition of KPIs related to Cross Vertical Sector Indicators (Sector-agnostic)

COP-PILOT defines a set of common key performance indicator KPI categories and KPIs, in an attempt to quantify in a homogeneous way how any vertical sector may assess certain measurable criteria, such as the levels of (i) Fragmentation, (ii) Security, and (iii) Automation, as well as the (iv) piloting infrastructure scale and (v) network availability and performance. These Vertical Sector-Agnostic (VSA) KPI categories are marked with the prefix KPI-VSA, followed by an acronym of the common KPI category name (e.g., FRA for Fragmentation, SEC for security, etc.). Table 2-8 defines these five categories and their IDs.

Table 2-8: Common Vertical Sector-agnostic KPI Categories where COP-PILOT makes impact.

KPI Category Prefix ID	KPI Category Name
KPI-VSA-FRA	Level of Fragmentation
KPI-VSA-SEC	Level of Security
KPI-VSA-AUT	Level of Automation
KPI-VSA-PIS	Piloting Infrastructure Scale
KPI-VSA-NAP	Network Availability and Performance

To assess these KPI categories in every cluster individually, this common prefix will be used by each cluster, followed by the cluster number (e.g., CL#1). Each KPI metric in such a category inherits this whole prefix (e.g., KPI-VSA-FRA-CL#1-) and appends a unique ever-increasing identifier to define a unique ID for each metric (e.g., KPI-VSA-FRA-CL#1-01).

Each of these common KPI categories above define a set of quantifiable KPI metrics that will facilitate the validation and KPI assessment in each cluster. This section classifies the KPI metrics per category and provides mathematic formulas to strictly define the way of measuring these KPI metrics across all COP-PILOT clusters.

2.2.1 KPIs related to Level of Fragmentation

This section addresses fragmentation, i.e., the degree to which end-to-end business processes are split across disconnected applications, requiring (i) manual handoffs, (ii) duplicate data, (iii) custom integrations, and (iv) context loss (traceability gaps). Table 2-9 lists the KPIs that assess the degree of fragmentation in the COP-PILOT ecosystem.

Table 2-9: KPIs related to Level of Fragmentation.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSA-FRA-APP	Application Proliferation per Process	Number of standalone applications or data silos required to support an end-to-end operation You may have a single end-to-end operation for your entire cluster or one end-to-end	**APP formula:** Σ (applications that comprise an end-to-end process) **APP type: Integer** •1-2 applications = Low •3-4 applications = Medium • ≥5 applications = High

		operation per UC (if UCs are completely standalone)	Higher = more fragmented **APP reference:** [12]
KPI-VSA-FRA-ICI	Integration Complexity Index	Measures how fragmented integrations are using a weighted formula of key integration methods.	**ICI formula:** Σ (integration weight × count) **ICI Integration weights** •Event/stream = 0.8 •API = 1 •Batch file = 2 •Manual export/import = 4 •No integration at all = 8 **ICI type: Decimal** Higher = more fragmented **ICI reference:** [13]
KPI-VSA-FRA-DDR	Data Duplication Rate	Measures how often the same data entity exists in multiple systems	**DDR formula:** Σ (Number of systems storing the same data entity)/Total number of data entities **DDR type:** Decimal Higher = more fragmented **DDR Example** Entities = Crop batch, Pest alert, Shipment Systems storing Crop batch = 4 Systems storing Pest alert = 3 Systems storing Shipment = 2 DDR = (4 + 3 + 2)/ 3 = 3.0 **DDR reference:** [14]
KPI-VSA-FRA-DI²	Data Interoperability Index	Measures the average number of data entities that comply with a standardized Data Model (e.g., ETSI NGSI-v2/LD) Shows the degree of compliance with data-related standards, thus implicitly assesses the interoperability of a solution at the data level	**DI² formula:** Σ (Data entities based on standardized data model) / Σ (total number of data entities) **DI² type:** Decimal in [0, 1] (Percentage) Higher = less fragmented (more interoperable) **DI² reference:** [15][16]

KPI-VSA-FRA-ETC	End-to-End Traceability Completeness	Inverse indicator of fragmentation. Measures the average number of traceable records in the system. The higher the better	**ETC** formula: Fully traceable records / Total records **ETC type:** Decimal in [0, 1] Higher = less fragmented (more interoperable) **ETC reference:** [17]
KPI-VSA-FRA-TFI	Total Fragmentation Index	Weights all the above fragmentation KPI metrics into a single executive KPI for assessing fragmentation	**TFI formula:** 0.3 x Normalized (APP) + 0.3 x Normalized (ICI) + 0.15 x Normalized (DDR) + 0.15 x (1 - DI^2) + 0.1 x (1 – ETC) **TFI score in [0, 100]** scale •0-30 = Well integrated •31-60 = Moderately fragmented •61-100 = Highly fragmented **TFI type:** Integer in [0, 100] Higher = more fragmented

2.2.2 KPIs related to Level of Security

Asking *"How secure is a system?"* can be a tricky question, therefore the key is to treat security as a set of measurable risk-reducing capabilities, then roll those up into KPIs that make sense at system and product level. That said, we attempt to answer an equivalent question: "How well does the system reduce security risk across the end-to-end flow?", for which we can provide quantifiable evidence.

As a result, our KPIs should measure:

- **Coverage** (are controls in place?)
- **Effectiveness** (do they work?)
- **Exposure** (what is still vulnerable?)
- **Response** (how fast do we detect and fix?)

Table 2-10: Security domains for assessing Level of Security.

Security domain name	Security KPI Metric(s) per domain
Federation	FED
Application & Integration	E2E-API-PROT, E2E-API-AUTH, E2E-EXT-AUTH
Data Protection	DATA-ENC
Detection & Response	E2E-EV-LOG

Table 2-11: KPIs related to Level of Security.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSA-SEC-FED	Federation Index	Percentage of system components using centralized IAM This KPI demonstrates maturity of centralized identity governance	**FED formula:** Number of components using IAM / Total number of components **FED type:** Decimal in [0,1] Higher = More secure **FED reference:** - ISO 27001 Identity & Access [20] - NIST Protective Identity Management, Authentication, and Access Control (PR.AA) [21] - DORA ICT risk management (Article 6) [22]
KPI-VSA-SEC-E2E-API-PROT	End-to-end API protection Index	Average number of application API calls protected by gateway or service mesh across an end-to-end process (which employs multiple applications)	**E2E-API-PROT formula:** Σ (Number of application APIs protected by gateway or service mesh) / Total number of application APIs in end-to-end process **E2E-API-PROT type:** Decimal in [0,1] Higher = More secure **E2E-API-PROT reference:** - ISO 27001 Network security [20] - NIST Protective Access Control (PR.AC) / Boundary Protection SC-7 [21] - DORA ICT risk management (Article 6) [22]
KPI-VSA-SEC-E2E-API-AUTH	End-to-end API authentication Index	Average number of API calls with authentication or authorization across an end-to-end process (which employs multiple applications)	**E2E-API-AUTH formula:** Σ (Number of application APIs with authentication or authorization) / Total number of application APIs in end-to-end process **E2E-API-AUTH type:** Decimal in [0,1] Higher = More secure **E2E-API-AUTH reference:** - ISO 27001 Access control [20] - NIST Identification and Authentication (IA) / Access Control (AC) [21]

			- DORA ICT security architecture (Article 9) [22]
KPI-VSA-SEC-E2E-EXT-AUTH	End-to-end outbound Authentication Index	Average number of application calls to external systems using strong auth (mTLS/OAuth) across an end-to-end process (which employs multiple applications)	**E2E-EXT-AUTH formula:** Σ (Number of authenticated calls to external systems) / Total number of calls to external systems **E2E-EXT-AUTH type:** Decimal in [0,1] Higher = More secure **E2E-EXT-AUTH reference:** - ISO 27001 Cryptography [20] - NIST System and Communications Protection (SC) / Identification and Authentication (IA) [21] - DORA ICT third-party risk management and oversight (Articles 28-44) [22]
KPI-VSA-SEC-E2E-EV-LOG	End-to-end Security event logging index	Average number of security events' logs across an end-to-end process (which employs multiple applications)	**E2E-EV-LOG formula:** Σ (Number of security events centrally logged/monitored) / Total number of security events **E2E-EV-LOG type:** Decimal in [0,1] Higher = More secure **E2E-EV-LOG reference:** - ISO 27001 Logging & monitoring [20] - NIST Audit and Accountability (AU) / System and Information Integrity (SI) [21] - DORA ICT-related incident management, classification, and reporting (Articles 17-19) [22]
KPI-VSA-SEC-DATA-ENC	Sensitive data encryption Index	Percentage of sensitive data encrypted at rest and in transit	**DATA-ENC formula:** Number of encrypted data operations / Total number of data operations **DATA-ENC type:** Decimal in [0,1] Higher = More secure **DATA-ENC reference:** - ISO 27001 Cryptography [20] - NIST Protective Data Security (PR.DS) [21] - DORA ICT security controls (Articles 9-15) [22]
KPI-VSA-SEC-TSI	Total Security Index (TSI)	Weights all the above security KPI metrics into a single	**TSI formula:** 0.2 x FED

		executive KPI for assessing security	+ 0.2 x E2E-API-PROT + 0.2 x E2E-API-AUTH + 0.1 x E2E-EXT-AUTH + 0.1 x E2E-EV-LOG + 0.2 x DATA-ENC **TSI score in [0, 100]** scale **TSI type:** Integer in [0, 100] Higher = more secure **TSI reference:** Derives from primitives referenced above
KPI-VSA-SEC-TSI-NIST	Total Security Index (TSI) by NIST	Re-Scales **KPI-VSA-SEC-TSI** from a [0-100] scale to a [0-5] maturity level as defined by the NIST Cybersecurity Framework [21]	**TSI-NIST formula:** Based on Table 2-12 **TSI-NIST score in [0, 5]** scale Follows Table 2-12 maps the range of the Total Security Index KPI defined in Table 2-11 to a more familiar range as defined by the NIST Cybersecurity Framework [21], essentially defining an equivalent KPI- VSA-SEC-TSI-NIST. Table 2-12, changing the scale to [0-5] according to NIST.

Table 2-12 maps the range of the Total Security Index KPI defined in Table 2-11 to a more familiar range as defined by the NIST Cybersecurity Framework [21], essentially defining an equivalent KPI-VSA-SEC-TSI-NIST.

Table 2-12: Map Total Security Index to maturity tiers of the NIST Cybersecurity Framework.

Maturity level	KPI-VSA-SEC-TSI value range	Meaning
0 – Non-existent	0-10	Security controls largely absent
1 – Initial	11-30	Ad-hoc security, inconsistent implementation
2 – Basic	31-50	Core controls exist but not systematic
3 – Defined	51-70	Security controls consistently implemented
4 – Managed	71-85	Security integrated across systems and monitored
5 – Optimized	86-100	Fully integrated, automated, and continuously improved

Finally, Table 2-13 clarifies which security aspects from DORA are relevant for COP-PILOT and how these pillars are mapped to the 8 Security KPIs defined in Table 2-11.

Table 2-13: Relevant DORA pillars for COP-PILOT KPIs [22].

KPI	DORA Pillars and relevant articles
KPI-VSA-SEC-FED	ICT risk management (Article 6)
KPI-VSA-SEC-E2E-API-PROT	ICT risk management (Article 6)
KPI-VSA-SEC-E2E-API-AUTH	ICT security architecture (Article 9)
KPI-VSA-SEC-E2E-EXT-AUTH	ICT third-party risk management and oversight (Articles 28-44)
KPI-VSA-SEC-E2E-EV-LOG	ICT-related incident mgmt.., classification, & reporting (Articles 17-19)
KPI-VSA-SEC-DATA-ENC	ICT security controls (Articles 9-15)
KPI-VSA-SEC-TSI	All the above as both KPIs aggregate all the above KPIs
KPI-VSA-SEC-TSI-NIST	

2.2.3 KPIs related to Level of Automation

Table 2-14 shows the levels of automation as commonly defined by 3GPP [18] and TMF [19]. The automation levels range in [0, 5], with no automation being at a level 0 and maximum (full) automation being at a level 5.

Table 2-14: Automation levels as per 3GPP [18] and TMF [19].

Automation Level	Meaning
0	**Manual operation:** No automation at all
1	**Assisted operation:** System provides insights, human executes
2	**Preliminary automation:** Partial executioN/Analysis based on human policy
3	**Intermediate Automation:** Full executioN/Awareness automation. System automates analysis/decisions, allowing closed loop operation based on policies
4	**Advanced Automation:** Full automation of execution, awareness analysis, and decision making, with partial intent-based handling
5	**Fully autonomous:** Complete self-management, including intent generation, full closed-loop, and self-optimization

Depending on the scenario and field of business where automation needs to be quantified, one should define a set of stages where automation can be assessed individually. The following example shows how automation is quantified in a "farm-to-fork" value chain for an agricultural stakeholder. Table 2-15 defines the various stages of this value chain along with the typical set of tools used per stage.

Table 2-15: Automation stages for assessing Level of Automation (CL3A example).

Stage Number	Stage Title	Typical tools used in stage
1	Crop planning & demand forecast	ERP, AI forecasting

2	Field operations (planting, irrigation)	IoT, Farm Mgmt System
3	Crop monitoring	Sensors, drones, analytics
4	Harvest decision	Analytics, human
5	Harvest execution	Farm system
6	Post-harvest processing	Materials Management Software (MES) or Warehouse Management System (WMS)
7	Quality inspection	Vision AI, human
8	Traceability & certification	Blockchain / Trace system
9	Logistics	Transportation & logistics management
10	Retail delivery & confirmation	ERP, POS integration
11	Compliance reporting	Regulatory system

Next, Table 2-16 assigns an automation level from Table 2-14 to each automation stage.

Table 2-16: Automation levels per stages for assessing Level of Automation (CL3A example).

Stage Title	Automation level as per 3GPP
Crop planning & demand forecast	3
Field operations (planting, irrigation)	4
Crop monitoring	4
Harvest decision	2
Harvest execution	3
Post-harvest processing	4
Quality inspection	1
Traceability & certification	3
Logistics	2
Retail delivery & confirmation	3
Compliance reporting	2

Moreover, Table 2-17 associates each automation stage with a weighted impact as not all stages exhibit the same importance in this specific value chain.

Table 2-17: Impact weight per stage for assessing Level of Automation (CL3A example).

Stage Title	Impact Weight
Crop planning & demand forecast	2
Field operations (planting, irrigation)	5

Crop monitoring	3
Harvest decision	3
Harvest execution	2
Post-harvest processing	2
Quality inspection	5
Traceability & certification	4
Logistics	4
Retail delivery & confirmation	3
Compliance reporting	2

Finally,

Table 2-18 puts all the above information together, by devising a total automation index in an end-to-end manner.

Table 2-18: KPIs related to Level of Automation.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSA-AUT-TAI	Total Automation Index	Measures the end-to-end automation in your system by weighing the above information into a single executive KPI for assessing automation	**TAI formula:** Σ(weight × level) / Σ(weight × max level) **TAI score in [0, 100]** scale **TAI type:** Integer in [0, 100] Higher = more automated **TAI reference:** Derives from primitives as defined by ETSI [18] and TMF [19]
KPI-VSA-AUT-TAI-3GPP	Total Automation Index by 3GPP	Measures the end-to-end automation in your system as per 3GPP [18] and TMF [19]	**TAI-3GPP formula:** Based on Table 2-19 **TAI-3GPP score in [0, 5]** scale Follows Table 2-19

Table 2-19: Map Total Automation Index to Automation levels as per 3GPP [18] and TMF [19].

KPI-VSA-AUT-TAI-3GPP Automation level	KPI-VSA-AUT-TAI value range	Meaning
0	0-10	Manual operation
1	11-30	Assisted operation
2	31-50	Preliminary automation
3	51-70	Intermediate Automation
4	71-85	Advanced Automation
5	86-100	Fully Autonomous

2.2.4 KPIs related to Piloting Infrastructure Scale

Table 2-20 lists important KPIs that reveal the scale of the COP-PILOT Clusters by several means.

Table 2-20: KPIs related to Piloting Infrastructure Scale.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSA-PIS-COV	Total covered area	Covered area in km^2 of all IoT domains (no other domains, such as those hosting apps)	**COV formula:** Σ (IoT domain area) **COV type:** Integer in km^2 **COV reference:** N/A – Explicitly recommended by the Project Officer and technical experts
KPI-VSA-PIS-REG-CNT	Geographic dispersion	Number of distinct geographic regions	**REG-CNT formula:** Number of distinct geographic regions in your cluster **REG-CNT type:** Integer > 0 **REG-CNT reference:** N/A – Explicitly recommended by the Project Officer and technical experts
KPI-VSA-PIS-DOM-CNT	Domain count	Number of administrative domains An administrative domain may span multiple geographic regions	**DOM-CNT formula:** Number of administrative domains in your cluster **DOM-CNT reference:** N/A – Explicitly recommended by the Project Officer and technical experts
KPI-VSA-PIS-DEV-CNT	Device count	Weighted device count (across all domains in your cluster)	**DEV-CNT formula:** Σ (device count × weight) **DEV-CNT Weights**

			•Simple sensor = 1 •Smart sensor = 2 •Gateway = 5 •5G cell = 8 •Edge compute node = 10 •Cloud compute node = 15 **DEV-CNT type:** Decimal **DEV-CNT reference:** N/A – Explicitly recommended by the Project Officer and technical experts
KPI-VSA-PIS-APP-CNT	Application count	Number of applications (across all domains in your cluster)	**APP-CNT formula:** Number of applications **APP-CNT reference:** N/A – Explicitly recommended by the Project Officer and technical experts
KPI-VSA-PIS-PROTO-CNT	IoT Protocol diversity	Number of communication protocols in use (LoRa WAN, MQTT, OPC-UA, etc.) across all domains in your cluster	**PROTO-CNT formula:** Number of communication protocols in use **PROTO-CNT type:** Integer The higher the better **PROTO-CNT reference:** N/A – Explicitly recommended by the Project Officer and technical experts
KPI-VSA-PIS-TIS	Total Infrastructure Scale Index	Weights the above KPIs into a single executive KPI for assessing infrastructure scale	**TIS formula:** log10(COV x REG-CNT x DOM-CNT x DEV-CNT x APP-CNT x PROTO-CNT **TIS score in [0, 100]** scale •0-30 = Low scale •31-60 = Moderate scale •61-100 = High scale **TIS type:** Integer in [0, 100] Higher = bigger by means of scale **TIS reference:** Derives from primitives referenced above

2.2.5 KPIs related to Network Availability and Performance

This KPI category refers only to COP-PILOT Clusters that employ private 5G network solutions to facilitate certain scenarios for their stakeholders. At the moment of writing this document, this KPI category is relevant only for Cluster 2, Cluster 3A and Cluster 4.

- In Cluster 2, two private 5G networks are deployed: one at the UPV campus and another at the Valencia Port.
- In Cluster 3A OTE offers a private 5G system that connects the sensors in BarbaStathis' farms with the necessary edge compute infrastructures of Cluster3A, i.e., (i) the Farm Management domain provided by AgroApps, (ii) the Pest Detection domain provided by AUA, and (iii) the Logistics & Traceability domain provided by iLINK.
- In Cluster 4 NOKIA offers a private 5G system in the Matanza domain, which reports the state of the vineyard in that area to other geo-dispersed cloud domains in Cluster 4.

Table 2-21: KPIs related to Network Availability and Performance.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSA-NAP-AV	Network availability	Percentage of time the private 5G network remains operational and reachable by endpoints/sensors.	Availability is a critical KPI for industrial/private 5G because manufacturing, safety and automation services require continuous connectivity and service continuity. Typical target values in URLLC scenarios exceed 99.9%–99.999%. Formula: Availability (%) = (Total operational time / Total observation time) × 100. Related to 5G URLLC service requirements defined by 3GPP TS 22.261
KPI-VSA-NAP-LAT	Network latency	One-way latency from sensor/device to platform through the private 5G network.	Low latency is fundamental in private 5G deployments supporting industrial automation, robotics, video analytics and safety-critical applications. Formula: Latency = Timestamp at platform ingress – Timestamp at sensor transmission. 5G URLLC targets low-latency communication. Related to 3GPP TS 22.261 URLLC requirements. In Clusters network deployments (a latency of 5-10 ms is expected, based on the deployment)
KPI-VSA-NAP-RATE	Network delivery rate	Effective throughput/data delivery rate from sensor to platform over private 5G	Throughput determines whether the private 5G network can sustain real-time sensor streams, video feeds and industrial telemetry. Formula: Delivery Rate = Bits received at platform ingress / observation time (bps). Relevant to eMBB and industrial IoT service performance in private 5G deployments.

KPI-VSA-NAP-PLR	Packet Loss Rate	Percentage of packets lost during transmission over the private 5G network	Packet loss directly affects reliability, video quality, industrial control loops and real-time monitoring services. Formula: PLR (%) = (Number of lost packets / Number of transmitted packets) × 100. Low packet loss is a key requirement for URLLC and industrial private 5G deployments. Related to 3GPP TS 22.261 reliability requirements.
KPI-VSA-NAP-JIT	Network Jitter	Variation in packet delay over time	Jitter impacts deterministic communications, video streaming, robotic control and time-sensitive industrial applications. Formula: Jitter = variation/inter-arrival delay between consecutive packets. Low jitter is essential for stable real-time private 5G services.
KPI-VSA-NAP-REL	Network Reliability	Probability that the network successfully delivers data within a defined time constraint	Reliability is a fundamental KPI for private 5G deployments supporting mission-critical and industrial automation services. In 5G URLLC, reliability targets may reach 99.999% for specific latency bounds. Reliability can be measured as the successful packet delivery ratio within the required latency threshold. Defined in 3GPP TS 22.261.
KPI-VSA-NAP-RSRP	RSRP	Measurement of the received signal power level from the 5G base station, used to assess coverage.	Synchronization Signal (SS) reference signal received power is defined as the linear average over the power contributions (in [W]) of the resource elements that carry secondary synchronization signals.
KPI-VSA-NAP-RSRQ	RSRQ	Indicator of signal quality, combining signal strength and interference levels.	Secondary Synchronization Signal Reference Signal Received Quality (SS-RSRQ) is defined as the ratio of N×SS-RSRP / NR carrier RSSI, where N is the number of resource blocks in the NR carrier RSSI measurement bandwidth.
KPI-VSA-NAP-SINR	SINR	Measurement of signal quality considering both interference and background noise.	SS Signal-to-Noise and Interference Ratio is defined as the linear average over the power contribution (in [W]) of the resource elements carrying secondary synchronization signals divided by the linear average of the noise and interference power contribution (in [W]).

The selected KPIs target both network availability and radio performance dimensions that are considered critical for private 5G deployments supporting industrial IoT, real-time monitoring and URLLC services. The KPIs are aligned with 5G performance indicators defined by 3GPP specifications and relevant literature on private 5G and industrial communications.

2.3 Definition of KPIs and KVIs related to the 5 COP-PILOT Vertical Sectors

This section defines vertical sector-specific business KPIs. Because COP-PILOT deals with 5 different vertical sectors, each corresponding to a dedicated Cluster, this section reports Business KPIs per Cluster (or vertical sector) as follows:

- Section 2.3.1 reports KPIs and KVIs for Cluster 1 "Business Integration in Mining".
- Section 2.3.2 reports KPIs and KVIs for Cluster 2 "Smart Sustainable IoT Solutions in Valencia".
- Section 2.3.3 reports KPIs and KVIs for Cluster 3A "AgriTech Transformation and Sustainability Initiative".
- Section 2.3.4 reports KPIs and KVIs for Cluster 3E "Edge Intelligence for Enhancing Grid Reliability in RES-Rich Distribution Grids".
- Section 2.3.5 reports KPIs and KVIs for Cluster 4 "Smart Vineyards & Sustainable Winery Ecosystems".

2.3.1 Cluster 1 KPIs and KVIs (Business Integration in Mining)

Table 2-22 lists Cluster 1-specific KPIs, defined to capture all the Use Case scenarios and piloting activities under this Cluster.

Table 2-22: KPIs related to Cluster 1.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSS-CL1-1.1	Vendor interoperability	Number of individual seismic sensor array vendors successfully integrated	Defined by Cluster in project
KPI-VSS-CL1-1.2	Simultaneous seismic sensor vendor interoperability	Number of seismic sensor vendors simultaneously used for processing	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL1-1.3	Distributed compute (E2C)	Distribution of processing across edge/cloud with pre-processing logic at edge and final compound processing at cloud	Defined by Cluster in project
KPI-VSS-CL1-1.4	Compute dynamic/auto-scaling for SLA compliance	Runtime observation of resource allocation and job queue size (as a proxy for processing SLA compliance)	Defined by Cluster in project
KPI-VSS-CL1-2.1	Rock bolt physical installation	The time required to physically install a rock bolt with automation	Defined by Cluster in project
KPI-VSS-CL1-2.2	Rock bolt configuration time	The time required to do software configuration for a new rock bolt	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL1-2.3	Sensor infrastructure scale	Number of rock bolts supported for positioning of assets	Defined by Cluster in project
KPI-VSS-CL1-2.4	Collaborative support	Number of partners supported for shared data processing	Defined by Cluster in project
KPI-VSS-CL1-2.5	Automatic tunnel inspection	Number of automated tunnel inspection reports	Defined by Cluster in project
KPI-VSS-CL1-2.6	Alarm detection latency	Time from sensor reading to user being alerted.	Defined by Cluster in project
KPI-VSS-CL1-2.7	Position update rate	Frequency of automatic positional updates of tracked assets and staff.	Defined by Cluster in project
KPI-VSS-CL1-2.8	Data reception performance	Data stream bandwidth - number of packets per second.	Defined by Cluster in project
KPI-VSS-CL1-2.9	System availability	Percentage of time of system availability.	Defined by Cluster in project

KPI-VSS-CL1-2.10	Capability integration	Integration between underground asset tracking and Mining 4.0 platform.	Defined by Cluster in project
KPI-VSS-CL1-2.11	Underground asset visualization	Visualization of underground asset condition in Mining 4.0.	Defined by Cluster in project
KPI-VSS-CL1-2.12	Data processing distribution	Distance from measurement to processing (sensor, gw, edge, cloud, datacenter)	Defined by Cluster in project
KPI-VSS-CL1-3.1	Commissioning time	Commissioning time for data pipelines	Defined by Cluster in project
KPI-VSS-CL1-3.2	Commissioning automation	The degree of automation in onboarding new devices: (a) data sources, (b) customers	Defined by Cluster in project
KPI-VSS-CL1-3.3	Data sample rate	Improved hardware should be capable to acquire data at a higher sampling rate, measured in Hz	Defined by Cluster in project
KPI-VSS-CL1-3.4	Scalability to large number of devices	Number of devices that can be managed by the complete data acquisition, storage and processing pipeline	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL1-3.5	Belt conveyor monitoring setup time, for either new or existing customers with known belt conveyor configuration	The time it takes for developers to set up and to commission the industrial AI and the backend services. It is assumed that the intelligent scraper technology Hosch-iris Discover is already installed and that the data flows from the site are established.	Defined by Cluster in project
KPI-VSS-CL1-4.1	E2C testbed integration coverage	Number of Cluster 1 use case environments or representative services from UC1.1–UC1.3 integrated or emulated in the UC1.4 testbed.	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL1-4.2	Heterogeneous compute platform coverage	Number of compute platforms included in the orchestration setup, e.g. edge, on premises/private infrastructure, and cloud.	Defined by Cluster in project
KPI-VSS-CL1-4.3	Automated E2C continuum provisioning	Ability and/or time required to automatically provision and set up the ColonyOS + Arrowhead edge-to-cloud continuum.	Defined by Cluster in project
KPI-VSS-CL1-4.4	State reconciliation success rate	Percentage of reconciliation processes where the system successfully converges from current state to desired state.	Defined by Cluster in project
KPI-VSS-CL1-4.5	Automated workload placement	Ability to place, scale, or rebalance workloads across edge/cloud resources under changing load. Baseline: manual/no autoscaling. Target: automated workload placement/autoscaling demonstrated.	Defined by Cluster in project

KPI-VSS-CL1-4.6	Fault recovery and task preservation	Ability to reassign/redeploy failed workloads or executors without loss of committed tasks.	Defined by Cluster in project
KPI-VSS-CL1-4.7	Observability and auditability coverage	Share of core ColonyOS components with logs, metrics, traces, and/or recorded process execution history.	Defined by Cluster in project
KPI-VSS-CL1-4.8	Secure service interoperability	Share of relevant inter-service interactions using secure service discovery, authentication/Authorization, TLS, and encrypted storage where applicable.	Defined by Cluster in project
KPI-VSS-CL1-4.9	UC1.4 testbed availability	Percentage of time the ColonyOS–Arrowhead testbed is available during evaluation windows.	Defined by Cluster in project

Table 2-23 outlines the key value indicators related to all the Use Case scenarios and piloting activities under Cluster 1.

Table 2-23: KVIs related to Cluster 1.

KVI ID	**KVI Name**	**Key Value related to a KVI**	**Associated Measurable Indicators**
KVI-VSS-CL1-1.1	Improved real-time decision-making capabilities in critical situations (i.e., large seismic events)	With improved scalability through distributed compute, and with improved SLA compliance, seismic processing results will continue to be delivered without added latency even when large seismic events happen, causing bursts of peak load. This contributes to improved overall capabilities related to safe evacuations and rapid decision making.	KPI-VSS-CL1-1.3 KPI-VSS-CL1-1.4
KVI-VSS-CL1-1.2	Flexible compute placement for seismic analytics	Seismic processing workloads can be placed more flexibly across edge and cloud to match customer-specific requirements, infrastructure constraints and data sovereignty needs.	KPI-VSS-CL1-1.3
KVI-VSS-CL1-1.3	Higher resolution seismic monitoring	With improved scalability, achieved through job distribution, seismic sensor arrays can be built denser (and larger), beyond current scalability limits without causing overload on the central processing system	KPI-VSS-CL1-1.3 KPI-VSS-CL1-1.4
KVI-VSS-CL1-1.4	Vendor independence	With support for multiple (simultaneous) seismic sensing vendors in one seismic monitoring system, operators are free to choose among vendors to build fit-for-purpose solutions. This breaks lock-in effects and contributes to improved competition and innovation in the market.	KPI-VSS-CL1-1.1 KPI-VSS-CL1-1.2

KVI-VSS-CL1-2.1	Cost efficiency and scalability of rock bolt deployments	Reduced cost and effort of installing and configuring rock bolts through a more automated deployment process. Scalability is inferred from reduced marginal deployment effort, since lower installation and configuration effort enables broader and more economically viable rollout	KPI-VSS-CL1-2.1 KPI-VSS-CL1-2.2
KVI-VSS-CL1-2.2	Cost efficiency of tunnel inspection	Greatly reduced need for costly and time-consuming daily or multiple-per-week manual tunnel inspections by automatically delivering status reports from installed rock bolts	KPI-VSS-CL1-2.5
KVI-VSS-CL1-2.3	Cost efficiency of lost asset localisation	Reduced cost and effort of locating lost assets through frequent positional updates of tracked assets	KPI-VSS-CL1-2.7
KVI-VSS-CL1-2.4	Worker safety in tunnel inspections	Improved worker safety by reducing the need for manual tunnel inspections in potentially hazardous areas through automatic status reporting from installed rock bolts.	KPI-VSS-CL1-2.5
KVI-VSS-CL1-2.5	Improved situational awareness of worker location	Improved worker safety through continuous awareness of underground worker location, enabling real-time assessment of whether personnel are present in hazardous areas after seismic events.	KPI-VSS-CL1-2.7
KVI-VSS-CL1-2.6	Timely hazard alerting for underground workers	Improved worker safety through timely alerts to workers and the mine operation center when tracked personnel are detected in hazardous areas, enabling rapid evacuation or other protective action.	KPI-VSS-CL1-2.6
KVI-VSS-CL1-2.7	Reduced fuel emissions from tunnel inspections	Reduced fuel emissions and associated environmental impact by minimizing the need for frequent vehicle-based manual tunnel inspections through automatic status reporting from installed rock bolts.	KPI-VSS-CL1-2.5
KVI-VSS-CL1-2.8	Extended functional lifetime of tracked assets	Extended functional lifetime of assets through improved location awareness and broader tracking coverage, enabled by frequent positional updates and more cost-efficient rock bolt deployment, thereby reducing asset loss, delayed recovery, and unnecessary replacement.	KPI-VSS-CL1-2.1 KPI-VSS-CL1-2.7
KVI-VSS-CL1-3.1	Improved and reliable	Higher degree of automation reduces human error and time for commissioning with foreseeable outcome.	KPI-VSS-CL1-3.1 KPI-VSS-CL1-3.2

	onboarding and commissioning		KPI-VSS-CL1-3.4 KPI-VSS-CL1-3.5
KVI-VSS-CL1-3.2	Higher accuracy in condition monitoring	Increased sample rates enable an improved accuracy of the belt condition monitoring as minor damages will not be missed.	KPI-VSS-CL1-3.3
KVI-VSS-CL1-4.1	Reduced IT integration and platform management effort	Reduced time and engineering effort spent on low-level platform integration, deployment, configuration, and orchestration, enabling mining technology providers and infrastructure owners to focus more resources on domain-specific value creation.	KPI-VSS-CL1-4.3 KPI-VSS-CL1-4.4 KPI-VSS-CL1-4.7
KVI-VSS-CL1-4.2	Scalable edge-to-cloud deployment capability for digital mines	Mining applications can be deployed, scaled, and managed across edge, on-premises, and cloud resources in a more flexible and scalable way, supporting realistic digital mine workloads and future large-scale pilots.	KPI-VSS-CL1-4.1 KPI-VSS-CL1-4.2 KPI-VSS-CL1-4.3 KPI-VSS-CL1-4.5 KPI-VSS-CL1-4.9
KVI-VSS-CL1-4.3	Improved operational resilience of distributed mining applications	Improved resilience and service continuity for distributed mining applications through automated recovery, workload reassignment, state reconciliation, and maintained system availability under changing workload or failure conditions.	KPI-VSS-CL1-4.4 KPI-VSS-CL1-4.5 KPI-VSS-CL1-4.6 KPI-VSS-CL1-4.7 KPI-VSS-CL1-4.9.
KVI-VSS-CL1-4.4	Secure and compliant industrial data and service integration	Mining stakeholders can exchange data and services across distributed industrial systems while respecting strict security, authentication, authorization, encryption, auditability, and data restriction requirements.	KPI-VSS-CL1-4.7 KPI-VSS-CL1-4.8,
KVI-VSS-CL1-4.5	Reduced cloud dependency and transmission overhead	Reduced need to transmit raw or high-volume data to cloud environments by enabling edge-local processing, filtering, and workload placement closer to data sources, thereby lowering bandwidth demand, cloud dependency, and potentially energy use.	KPI-VSS-CL1-4.5

Cluster 1 approach to common VSA indicators

Cluster 1 uses the VSA categories defined in Section 2.2 as a common classification framework for relating Cluster-specific validation evidence to the project-wide evaluation methodology. However, the primary evidence for Cluster 1 validation is provided by the Cluster-specific KPIs and associated KVIs defined in Section 2.3.1. These indicators have been defined according to the measurable capabilities of the Cluster 1 TRL6 testbed and the needs of the mining use cases.

Where a VSA category is relevant to Cluster 1, the corresponding assessment is operationalised through one or more KPI-VSS-CL1 indicators. This avoids duplicative measurement and ensures that the reported evidence is based on indicators that are meaningful, verifiable, and actionable for Cluster 1 stakeholders. Where a VSA category is not applicable to the Cluster 1 validation setup, this is explicitly stated and justified in the mapping table below.

Table 2-24: Mapping of common VSA categories to Cluster 1-specific KPI evidence.

VSA KPI category	Applicability to Cluster 1	Evaluation approach	Relevant Cluster 1 KPIs
Level of Fragmentation	Partly applicable	Derived from interoperability and integration evidence	KPI-VSS-CL1-1.1, 1.2, 2.10, 3.4, 4.1, 4.8
Level of Security	Applicable within defined COP-PILOT interfaces	Derived from secure service interoperability, auditability and platform security evidence	KPI-VSS-CL1-4.7, 4.8
Level of Automation	Applicable	Derived from automation, provisioning, workload placement and commissioning KPIs	KPI-VSS-CL1-1.4, 2.2, 2.12, 3.2, 4.3, 4.5
Piloting Infrastructure Scale	Applicable	Derived from UC-specific scale and testbed integration KPIs	KPI-VSS-CL1-1.5, 2.3, 2.8, 3.4, 4.1, 4.2
Network Availability and Performance	Not applicable	Cluster 1 does not use private 5G network deployment as part of its validation setup	N/A

2.3.2 Cluster 2 KPIs and KVIs (Smart Sustainable IoT Solutions in Valencia)

Table 2-25 lists Cluster 2-specific KPIs, defined to capture all the Use Case scenarios and piloting activities under this Cluster.

Table 2-25: KPIs related to Cluster 2.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSS-CL2-1	Traffic State Classification Accuracy	Measures the rate at which the 5GRadars report the correct traffic state, evaluated against video feed of the collocated cameras. Captured as a percentage (%)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL2-2	Berthing detection accuracy	Measures the accuracy in the detection of a berthing event. Captured by comparing radar data with other sources of information such as AIS NMEA messages (Detected Berths / Total Berths) (%).	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL2-3	Berthing detection false positive rate	Measures the ratio of detected berths that are false positives. Captured as the number of false positives divided by total berthing detections (%).	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL2-4	HCHO Real-time Monitoring Coverage	Percentage of Nespra NM-WSLRW-G4-HCHO-EU formaldehyde sensors at Almussafes industrial park actively transmitting data	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL2-5	Waste Threshold Alerts Notified	Percentage of waste container capacity exceedances that successfully trigger and deliver an automated alert to operators via the COP-PILOT Multi-Modal Notification Service.	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS- CL2-6	System uptime	Measures the reliability of the system to guarantee continuous operation with minimal downtime. Captured as a percentage (%).	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL2-7	Ship detection accuracy	Number of correctly detected / total number of ships (%)	Defined by Cluster in project

KPI-VSS-CL2-8	Detection range	Range at which the radars can monitor the ship for berthing assistance (m)	Defined by Cluster in project
KPI-VSS-CL2-9	Water level radar measurement standard deviation	Standard deviation of measurements in a day without flood events	Defined by Cluster in project
KPI-VSS-CL2-10	Water level radar relative measurement error	Relative error percentage compared to reference measurement	Defined by Cluster in project
KPI-VSS-CL2-11	Water level radar up time	Uptime of the water level radar devices	Defined by Cluster in project
KPI-VSS-CL2-12	HCHO Threshold Alerts Notified	Number of automated alerts triggered by HCHO threshold exceedances and delivered to industrial park operators via COP-PILOT Multi-Modal Notification Service	Defined by Cluster in project
KPI-VSS-CL2-13	Occupancy Data Freshness	Percentage of expected 1-minute reporting intervals from NM-VS135 sensors received at UPV OrionCB within a 2-minute latency window	Defined by Cluster in project
KPI-VSS-CL2-14	Traffic-jam Detection False Positive Rate	Measures the percentages of traffic jam notifications obtained from 5GRadars that are false positive. Captured as a percentage (%)	Defined by Cluster in project

Table 2-26 outlines the key value indicators related to all the Use Case scenarios and piloting activities under Cluster 2.

Table 2-26: KVIs related to Cluster 2.

KVI ID	KVI Name	Key Value related to a KVI	Associated Measurable Indicators
KVI-VSS-CL2-1	User Satisfaction	Public Satisfaction	Linked to KPI-SOC-CL2-2, KPI-VSS-CL2-6, KPI-VSS-CL2-11 and KPI-VSS-CL2-13
KVI-VSS-CL2-2	Validation Performance	Productivity	Linked to KPI-VSS-CL2-4, KPI-VSS-CL2-8, KPI-VSS-CL2-12 and KPI-SDG-CL2-1
KVI-VSS-CL2-3	Market readiness	Commercial Viability	Linked to KPI-VSS-CL2-5 and KPI-SDG-CL2-2

2.3.3 Cluster 3A KPIs and KVIs (AgriTech Transformation and Sustainability Initiative)

Table 2-27 lists Cluster 3A-specific KPIs, defined to capture all the Use Case scenarios and piloting activities under this Cluster.

Table 2-27: KPIs related to Cluster 3A.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSS-CL3A-1	Farming Resource Optimization	Crop Yield & Resource Efficiency: Increase crop yield per hectare; decrease water, fertiliser, and pesticide use per hectare	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3A-2	Agri-Ecosystem Integration & Security	System Integration & Security: Achieve full ecosystem integration; minimise security incidents	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3A-3	Smart Logistics & Supply Chain Sustainability	Logistics Efficiency & Sustainability: Lower logistics costs and carbon footprint per production unit; reduce transit spoilage, ensuring maximum freshness	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3A-4	AI-Driven Crop Management	Accuracy & Decision Speed: Improve pest and disease management accuracy; expedite decision-making with real-time analytics	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3A-5	UAV–UGV Autonomous Weed Management Efficiency	End-to-end efficiency: of the autonomous weed detection and targeted intervention cycle, spanning UAV flight, AI-based weed mapping, UGV mission activation, and precision spot-spraying execution; reduction in herbicide volume applied compared to conventional uniform spraying.	KPI introduced to address UC#3A.2 objectives on autonomous agri-robotics.

Table 2-28 outlines the key value indicators related to all the Use Case scenarios and piloting activities under Cluster 3A.

Table 2-28: KVIs related to Cluster 3A.

KVI ID	KVI Name	Key Value related to a KVI	Associated Measurable Indicators
KVI-VSS-CL3A-1	Agricultural Input Cost Savings for Contract Farmers	Reduction in per-hectare production costs through precision application of pesticides, fertilisers, and water, enabled by real-time monitoring and data-driven recommendations from AgroApps 360.	KPI-VSS-CL3A-1 (resource reduction %); estimated €/ha cost saving calculated per pilot season; reduction in agronomist field visit costs (fewer physical visits required)
KVI-VSS-CL3A-2	Trusted & Traceable AgriFood Supply Chain	Establishment of an end-to-end, data trail from field to processing facility and PoS enabling Barba Stathis to demonstrate verifiable product safety, provenance, and sustainability compliance to end-consumers	KPI-VSS-CL3A-2 (integration & security targets); KPI-VSS-CL3A-3 (logistics traceability coverage at 100%); number of blockchain-recorded events per delivery cycle; audit readiness score.
KVI-VSS-CL3A-3	Supply Chain Efficiency & Product Freshness	Improved freshness and reduced spoilage % of delivered spinach, combined with lower logistics costs, enabling Barba Stathis to maintain quality standards at lower operational cost.	KPI-VSS-CL3A-3 (spoilage reduction, CO_2 reduction, cost reduction); number of deliveries meeting freshness threshold at BAR facility gate;
KVI-VSS-CL3A-4	Shift from Reactive to Predictive Crop Protection	Demonstrated transition of crop protection decision-making from calendar-based, manual scouting to AI-triggered, data-driven interventions, reducing crop losses, chemical over-use, and missed treatment windows.	KPI-VSS-CL3A-4 (detection accuracy ≥70%;); KPI-VSS-CL3A-5 (UAV mission success rate); number of pest/disease events correctly anticipated vs. missed per season
KVI-VSS-CL3A-5	Environmental Impact Reduction in Leafy Vegetable Production	Measurable reduction of the environmental footprint of spinach cultivation through precision inputs, autonomous robotic interventions, and optimised logistics, contributing to EU Green Deal and Farm-to-Fork strategy targets	KPI-VSS-CL3A-1 (pesticide −20%, water −15%); KPI-VSS-CL3A-5 (herbicide −25%); KPI-VSS-CL3A-3 (CO_2 −10%); estimated reduction in chemical runoff into soil

2.3.4 Cluster 3E KPIs and KVIs (Edge Intelligence for Enhancing Grid Reliability in RES-Rich Distribution Grids)

Table 2-29 lists Cluster 3E-specific KPIs, defined to capture all the Use Case scenarios and piloting activities under this Cluster.

Table 2-29: KPIs related to Cluster 3E.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSS-CL3E-1	RES Intermittency	Reduction of RES intermittency	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-2	Grid Overload	Reduction of over-voltages and overloaded MV lines	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-3	Flexibility Activation Time	Reduction of total flexibility activation time	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-4	Edge Decision-Making	Cost reduction for decision-making due to not sending data centrally	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-5	Biogas Plant Profitability	Increase of biogas plant profits due to predictive maintenance	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-6	Biogas Plant Unplanned Downtime	Reduction of hours of unplanned biogas plant production outages	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-7	Biogas By-Product Cost	Biogas plant by-product cost reduction due to flexibility gains	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL3E-8	EV Charging Demand Forecasting Accuracy	Improvement in per-point EV charging demand forecasting accuracy through edge-based AI models,	arXiv:2506.04294 (link)
KPI-VSS-CL3E-9	EV Charger Uptime	Reduction of unplanned EV charger downtime through edge AI fault prediction and anomaly detection	arXiv:2603.08736 (link)
KPI-VSS-CL3E-10	Flexibility Estimation Accuracy	Accuracy of edge-based flexibility estimation compared to actual DER behaviour.	Cluster-level KPI aligned with UC#3E.1 requirement KPI#3E.1.2 in COP-PILOT D2.1 Annex 8
KPI-VSS-CL3E-11	EV Charger Fault Prediction Activity	Percentage of EV charging sessions at UC#3E.2 sites for which at least one fault prediction was generated by the edge AI system, demonstrating active and continuous operation of the predictive maintenance layer across all monitored chargers	Cluster-level KPI aligned with UC#3E.2 requirement KPI#3E.2.3 in COP-PILOT D2.1 Annex 8; further supported by arXiv:2603.08736

Table 2-30 outlines the key value indicators related to all the Use Case scenarios and piloting activities under Cluster 3E.

Table 2-30: KVIs related to Cluster 3E.

KVI ID	KVI Name	Key Value related to a KVI	Associated Measurable Indicators
KVI-VSS-CL3E-1	Edge-Based Flexibility Orchestration	Ability to orchestrate edge-based flexibility response under 1 second latency for a distribution grid with more than 100 nodes	KPI-VSS-CL3E-3; KPI-VSS-CL3E-10; KPI#3E.1.6
KVI-VSS-CL3E-2	Renewable Integration at Distribution Level	System enables greater integration of renewables at the distribution level by more than 10% through real-time DER coordination and EV load profile smoothing during peak solar/wind availability	KPI-VSS-CL3E-1; KPI-VSS-CL3E-2; SR_001
KVI-VSS-CL3E-3	CO_2 Optimisation of Charging Energy	Percentage of total charging energy dynamically optimised to reduce stress on the grid during high carbon-intensity periods, and estimated CO_2 emissions avoided through reduced energy waste and improved charger uptime	KPI-VSS-CL3E-8; KPI-VSS-CL3E-9; SR_006
KVI-VSS-CL3E-4	Biogas Equipment Lifetime Extension	Edge-enabled analytics increase biogas plant equipment lifetime by enabling timely interventions, targeting more than 5% asset lifespan extension and sustainable biogas-based grid integration reducing reliance on fossil backup	KPI-VSS-CL3E-5; KPI-VSS-CL3E-6; KVI#E.3.1; SR_004
KVI-VSS-CL3E-5	Reduced Emergency Maintenance Visits	Reduced number of emergency maintenance visits at EV charging sites, lowering cost and response time for rural and highway locations, through proactive edge AI fault detection	KPI-VSS-CL3E-9; KVI#3E.2.6; BR_003
KVI-VSS-CL3E-6	Local Energy Autonomy & EU Digital Sovereignty	Enhancing biogas reliability contributes to local energy autonomy and resilience, while local analytics and sovereignty-preserving architecture align with EU digital autonomy goals	KPI-VSS-CL3E-5; KPI-VSS-CL3E-6; KVI#E.3.4; KVI#E.3.7

2.3.5 Cluster 4 KPIs and KVIs (Smart Vineyards & Sustainable Winery Ecosystems)

Table 2-31 lists Cluster 4-specific KPIs, defined to capture all the Use Case scenarios and piloting activities under this Cluster.

Table 2-31: KPIs related to Cluster 4.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-VSS-CL4-1	Recovery rate for IoT sensors	for UC#4.1 -- successfully achieve an 80% recovery rate for IoT sensors, ensuring they can be reused within their 12-month lifecycle through thorough cleaning and rigorous retesting.	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-2	Water Use Optimisation (%)	Support system's irrigation insights to reduce water use. ≥20% reduction of water consumption	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-3	Enhanced application usability	for UC#4.3 -- Enhancing application usability and customization, optimizing OEE with well-established KPIs from past insights, and enabling seamless integration of new use cases.	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-4	Ground Infrastructure Reduction (%)	Minimise reliance on hardware soil moisture sensors using satellite data. ≤2 needed sensors per location	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-5	Water Consumption Reduction (%)	Provide insights that prevent over-irrigation and runoff. ≥20% reduction of water consumption while keeping same crop performance	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-6	Soil Health Monitoring Score	Retain historical data for soil condition analysis. Keep storage of 100% of recorded data	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-7	Stakeholder Inclusivity Score	Ensure access for both smallholders and enterprises; include multilingual support At least 2 supported languages	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-8	Energy Efficiency Gain (%)	Optimise backend system to minimise cloud resources; Optimize system algorithms to reduce processing power needs, affecting system software and IoT device firmware. **A.** ≥30% reduction of cloud resources consumption; **B.** 10% reduction in power usage of IoT devices based on their energy consumption records.	KPI introduced in the COP-PILOT Grant Agreement document

KPI-VSS-CL4-9	GDPR Compliance Score	Guarantee secure and compliant handling of user and sensor data. 100% compliance audits passed	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-10	User Satisfaction Score	Provide intuitive and easy-to-use platform interface for lifecycle monitoring; The interface must be intuitive and accessible, including for users with limited digital literacy. ≥80% positive user feedback in UX surveys	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-11	System Affordability Score	Provide free or low-cost entry-level tiers for small and first-time users ≥50% cost reduction for new users	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-12	Scalability Performance Score	Validate solution scalability by applying successful IoT lifecycle management model to other verticals and EU regions; Develop a scalable model for adoption in other processes, affecting deployment architecture, configuration templates, and documentation. Successful implementation in at least 3 EU countries; Expansion into 1+ process based on scalability reports generated from the deployment environment	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-13	Integration & Maintenance Efficiency Index	Ensure low-cost integration and straightforward maintenance of IoT devices through standardized orchestration workflows. Reduce integration time and costs by ≥40%	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-14	Cost Savings (%)	The system must reduce operational costs over time compared to traditional sensor-based irrigation solutions. Reduce costs by ≥ 30%	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-15	Profitability Index	The system should help users increase profitability through better yields, reduced water use, and operational efficiency. Increase in profitability ≥ 10%	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-16	Data Management Quality Score	Implement robust data backups, fallbacks for cloud services, and alerting for data ingestion failure. ≥95% automated recover in case of data failure	KPI introduced in the COP-PILOT Grant Agreement document

KPI-VSS-CL4-17	Asset lifecycle improvement	Track real-time status and lifecycle data for IoT sensors; Implement monitoring of sensor health and predictive maintenance, affecting IoT devices, maintenance scheduling system, and sensor monitoring software. ≥95% lifecycle transparency accuracy; 20% increase in device lifespan based on device status logs and sensor failure alerts	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-18	Waste reduction (%)	Enable reduction of IoT-related e-waste generation through circular economy practices; Detect and minimize production inefficiencies through real-time monitoring, affecting production line sensors, monitoring dashboard, and data processing modules ≥50% reduction of IoT device e-waste; 15% decrease in defective products based on production sensor records, quality control reports, and the defect tracking system integrated into COP-PILOT	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-19	Social Equity Score	Improve availability of IoT sensors for healthcare providers to enhance patient care; Develop a multilingual and role-based dashboard for diverse users, affecting UI/UX components, language translation modules, and user role management system. ≥30% improvement in device availability; System accessibility rating above 80% in user surveys	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-20	Workforce productivity index	Automate repetitive monitoring tasks to allow workers to focus on high-value activities, affect monitoring scripts, task scheduling modules, and user interfaces. 25% reduction in manual data entry based on automated task system logs.	KPI introduced in the COP-PILOT Grant Agreement document
KPI-VSS-CL4-21	Workforce upskilling rate (%)	Reduce manual work and optimize production with automation, affecting production control systems, workflow automation tools, and manual input interfaces. 30% reduction in operational costs based on a before-and-after comparison	KPI introduced in the COP-PILOT Grant Agreement document

		using accounting records and ERP reports.	
KPI-VSS-CL4-22	Interoperability Score	Ensure compatibility with existing winery ERP and MES systems, affecting API layer, data exchange modules, and integration middleware. Full API support for integration based on documented ERP/MES integration tests, successful API call logs, and validated system connectivity.	KPI introduced in the COP-PILOT Grant Agreement document

Table 2-32 outlines the key value indicators related to all the Use Case scenarios and piloting activities under Cluster 4.

Table 2-32: KVIs related to Cluster 4.

KVI ID	KVI Name	Key Value related to a KVI	Associated Measurable Indicators
KVI-VSS-CL4-1	Water Use Optimisation	Resource Efficiency	KPI-VSS-CL4-2
KVI-VSS-CL4-2	Reduction of Ground Infrastructure	Resource Efficiency	KPI-VSS-CL4-4
KVI-VSS-CL4-3	Water Use Efficiency	Resource Efficiency	KPI-VSS-CL4-5
KVI-VSS-CL4-4	Long-Term Soil Health Monitoring	Resource Efficiency	KPI-VSS-CL4-6
KVI-VSS-CL4-5	Ease of Use	Inclusivity	KPI-VSS-CL4-7 KPI-VSS-CL4-11
KVI-VSS-CL4-6	Energy Efficiency	Resource Efficiency	KPI-VSS-CL4-8
KVI-VSS-CL4-7	Data Privacy Trust	Data Autonomy	KPI-VSS-CL4-9
KVI-VSS-CL4-8	User Satisfaction Improvement	Public Satisfaction	KPI-VSS-CL4-10
KVI-VSS-CL4-9	System Scalability	Resource Efficiency	KPI-VSS-CL4-12
KVI-VSS-CL4-10	Scalable Architecture	Resource Efficiency	KPI-VSS-CL4-13
KVI-VSS-CL4-11	Operational Cost Savings	Cost Efficiency	KPI-VSS-CL4-14
KVI-VSS-CL4-12	Profitability & Competitiveness	ROI	KPI-VSS-CL4-15
KVI-VSS-CL4-13	Robust Data Management	Operational Efficiency	KPI-VSS-CL4-16
KVI-VSS-CL4-14	Sustainable Winery Production	Environmental Impact	KPI-VSS-CL4-21
KVI-VSS-CL4-15	Digital Transformation MES	Scalability Performance	KPI-VSS-CL4-12

2.4 Definition of KPIs related to Scientific Community

Table 2-33 lists KPIs related to expected Scientific outcomes throughout COP-PILOT.

Table 2-33: KPIs related to expected Scientific Outcomes.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-SCI-1	Number of academic publications on edge computing (mid-term)	50% increase in academic publications on edge computing (mid-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SCI-2	Number of research papers (mid-term)	5 research papers or technical reports within the first 2 years of COP-PILOT (mid-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SCI-3	Number of projects capitalizing on COP-PILOT assets (long-term)	5+ future R&D and R&I projects capitalizing on the assets of COP-PILOT and advancing the research on emerging Smart IoT Platforms and decentralized intelligence (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document

2.5 Definition of KPIs related to Economy

Table 2-34 lists KPIs related to expected Economic outcomes throughout COP-PILOT.

Table 2-34: KPIs related to expected Economic outcomes.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-ECO-1	Number of partnerships (mid-term)	≥ 10 new strategic partnerships between industry stakeholders within the first year of project completion (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-ECO-2	Adoption rate (long-term)	50% increase in the adoption rate of COP-PILOT within two years of project completion (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-ECO-3	Edge computing market share (long-term)	Capture a 20% market share of the edge computing solutions market within 5 years post-project completion (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-ECO-4	Adoption rate (long-term)	400+ enterprises adopting and using COP-PILOT for their smart IoT-based applications within 5 years of project completion (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-ECO-5	New businesses launched by COP-PILOT (long-term)	30+ new businesses launched by using COP-PILOT open platform within 5 years of project completion (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-ECO-6	Reduced OPEX (long-term)	30% reduced OPEX for services adopting COP-PILOT technology (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document

2.6 Definition of KPIs related to Technology

Table 2-35 lists KPIs related to expected Technological outcomes throughout COP-PILOT.

Table 2-35: KPIs related to expected Technological outcomes.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-TEC-1	Long-term increase in deployed COP-PILOT edge solutions	30% increase in the deployment of COP-PILOT-supported edge solutions within 5 years of project completion	KPI introduced in the COP-PILOT Grant Agreement document
KPI-TEC-2	Number of interfaces and protocols tested across different clusters	Test 20 interfaces and protocols across different piloting clusters	KPI introduced in the COP-PILOT Grant Agreement document
KPI-TEC-3	Long-term number of edge computing solutions stemming from entrepreneurship	20 new edge computing solutions by midcaps, SMEs, and startups within 5 years of project completion (long-term goal)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-TEC-4	Long-term increase in automation by reducing service provisioning time	Reduced provisioning and deployment time of complex cross sector applications enhanced with smart and automation services by at least an order of magnitude (10x faster) with respect to current edge configurations within 5 years of project completion	KPI introduced in the COP-PILOT Grant Agreement document
KPI-TEC-5	Long-term increase in QoE for end users of COP-PILOT	Increased QoE for end users of COP-PILOT continuous service environment (target > 4.3 according to ITU-T SG12 standard) within 5 years of project completion	KPI introduced in the COP-PILOT Grant Agreement document

2.7 Definition of KPIs related to Society

Societal impact can be studied in many ways. According to the COP-PILOT GA, such an impact can be made by e.g., (i) increasing public trust in emerging technologies brought (or promoted) by COP-PILOT at scale, (ii) contributing to climate changes that positively impact the EU citizens, etc. Instead of making generic and potentially "disconnected" societal impact claims, COP-PILOT shifted societal impact towards the 5 vertical business sectors, aiming to find more concrete impact indicators related with the 5 Clusters. Table 2-36 lists KPIs related to expected Societal outcomes throughout COP-PILOT's Cluster pilot activities.

Table 2-36: KPIs related to expected Societal outcomes.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-SOC-CL1-1	*	*	*
KPI-SOC-CL2-1	User Satisfaction Improvement	Measures the percentage of stakeholders' satisfaction rate. Captured through surveys launched among stakeholders (e.g., city technicians, planners) to assess satisfaction, receive feedback for possible solution improvements, and determine the percentage who rate the new system as satisfactory or highly satisfactory based on usability and reliability.	References SDG 3, SDG 10, and SDG 15. Linked to KV Public Satisfaction and KVI User Satisfaction.
KPI-SOC-CL3A-1	Consumer Access to Safe, Traceable & Sustainably Produced Leafy Vegetables	Measures the extent to which end consumers benefit from the ATSI pilot outcomes in terms of improved product safety, reduced chemical residues, and verifiable traceability from field to point of sale. Captured through qualitative — assessment of consumer-facing transparency enabled by the traceability infrastructure, evaluated via Barba Stathis' existing quality assurance and product labelling processes	Aligned with the EU Farm-to-Fork Strategy's objective of ensuring safe, nutritious food and increasing transparency across food supply chains. References SDG 2 (food safety and nutrition), SDG 3 (reduced chemical exposure), and SDG 12 (responsible consumption). Linked to KVI-VSS-CL3A-2.
KPI-SOC-CL3A-2	Digital Empowerment of Contract Farmers	Measures the degree to which contracted farmers in the Barba Stathis network gain meaningful, practical access to digital precision agriculture tools as a direct result of COP-PILOT. Captured through the reduction in manual labour hours per farmer and per agronomist across the pilot season.	Aligned with Horizon Europe's societal impact requirements and the EU Farm-to-Fork Strategy's commitment to rural digitalisation and farmer wellbeing. References SDG 8 (Decent Work) and SDG 10 (Reduced Inequalities).

			Linked to KPI-VSS-CL3A-1 and KVI-VSS-CL3A-1.
KPI-SOC-CL3E-1	Reliable Access to EV Charging and Clean Energy for Communities	Measures the improvement in service availability for EV users and grid consumers in Western Greece resulting from predictive maintenance and grid flexibility management. Captured through reduction in unplanned downtime at EV charging stations and increased reliability of biogas-based electricity injection into the grid.	Aligned with SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities).
KPI-SOC-CL3E-2	Digital Upskilling of Energy Sector Workers	Measures the degree to which operational staff gain practical access to AI-driven monitoring and analytics tools as a direct result of COP-PILOT. Captured through reduction in manual monitoring hours and number of personnel actively using COP-PILOT dashboards.	Aligned with SDG 8 (Decent Work and Economic Growth) and SDG 4 (Quality Education).
KPI-SOC-CL4-1	Safer and more inclusive digital field operations through trusted IoT LCM	Measures the extent to which Cluster 4 enables safer and more inclusive digital field operations through field-worker support and trusted IoT sensor lifecycle management. It is assessed through positive user feedback on usability and trust, the number of monitored operational sessions, and the availability of lifecycle-traceable sensors in pilot workflows	Aligned with Horizon Europe societal impact objectives and SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production).

* Cluster 1 are evaluating societal and sustainability impact through KVIs supported by measurable proxy indicators, qualitative assessment, stakeholder feedback, and where relevant modelled estimates. Direct real-world impact metrics such as reduced accident rates or verified CO_2 reductions cannot be fully validated within a TRL6 testbed and should therefore be treated as expected post-project impacts, not as hard project-level KPIs.

2.8 Definition of KPIs related to Standardization

Table 2-37 lists KPIs related to expected Standardization outcomes throughout COP-PILOT.

Table 2-37: KPIs related to Standardization.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-SDO-1	New ETSI Development Group	1x new open-source ETSI group that will promote COP-PILOT's End-to-End Service Orchestrator (based on Maestro) as a de facto overlay to ETSI OSL	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-2	Updated conformance testing for ETSI NGSI-LD	Number of updates to the ETSI NGSI-LD conformance tests throughout the IoT integration activities across the COP-PILOT piloting clusters	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-3	ETSI TC DATA PoC#1	PoC to ETSI TC DATA on TMF-compliant Data-aaS through integration between ETSI OpenSlice and TID's NGSI-compliant SmartCity platform	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-4	ETSI SDG OSL PoC#1	PoC activity involving number of formal presentations and validation artifacts uploaded by the ETSI SDG OSL channels with regards to GitOps-based Service Deployments	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-5	ETSI SDG OSL PoC#2	PoC activity involving number of formal presentations and validation artifacts uploaded by the ETSI SDG OSL channels with regards to Business Layer Integration	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-6	Open-source contributions to ETSI OSL	Open-source contributions to ETSI OSL	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-7	Potential extensions to TMF data models and APIs	Potential extensions to TMF data models and APIs	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-8	ETSI ISG ZSM Presentation	1x Presentation to ETSI ZSM on Alignment between the COP-PILOT orch. platform with the ETSI ZSM architecture.	KPI introduced in the COP-PILOT Grant Agreement document

KPI-SDO-9	ETSI ISG ZSM PoC#1	1x PoC to ETSI ZSM on Intelligent service onboarding and ordering: Mapping with the Intelligent block of the ZSM Architecture	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-10	ETSI ISG ZSM PoC#2	1x PoC to ETSI ZSM on Automated SLA assurance: Mapping with the Intelligent-Orchestration-Control blocks of the ZSM architecture	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-11	ETSI ISG ZSM PoC#3	1x Joint PoC to ETSI ZSM and ETSI OSL on service and resource orchestration of cross-sector large-scale IoT deployments	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-12	ETSI ISG ZSM PoC#4	1x PoC to ETSI ZSM on Extending the ZSM Domain and Cross-domain Integration fabric with security and trust primitives	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-13	ETSI ISG ZSM PoC#5	PoC to ETSI ZSM on Secure & Automated platform expansion to new infrastructure domains	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-14	Open-source contributions to ETSI HypO	30 open-source contributions to the HypO service orchestrator (previously known as Maestro)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-SDO-15	Open-source contributions to OpenZiti	3 open-source contributions to OpenZiti	KPI introduced in the COP-PILOT Grant Agreement document

2.9 Definition of KPIs related to Communication

Table 2-38 lists KPIs related to expected Communication outcomes throughout COP-PILOT.

Table 2-38: KPIs related to Communication.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-COM-1	Number of project website visits	> 3000 visits on the project website	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-2	Number of blog entries and readers of web content	≥ 24 entries and > 250 readers of blogs and related web content	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-3	Number of followers and views on social media	>250 followers and >2000 views on social media accounts	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-4	Number of videos and views on YouTube	≥ 5 videos and >1000 views on YouTube	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-5	Number of presentations and visits in booths	≥ 3 presentations and >500 visits of presentations in booths	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-6	Number of contacts by leaflet/flyer distribution	≥ 1500 and >100 new contacts by leaflet and flyers distributed	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-7	Number of actions and viewers from interviews and press releases	≥ 8 actions and >1000 viewers from interviews and press releases	KPI introduced in the COP-PILOT Grant Agreement document
KPI-COM-8	Number of newsletters and recipients by newsletters and mail campaigns	≥ 4 newsletters and >100 recipients by newsletters and mail campaigns	KPI introduced in the COP-PILOT Grant Agreement document

2.10 Definition of KPIs related to Dissemination

Table 2-39 lists KPIs related to expected Dissemination outcomes throughout COP-PILOT.

Table 2-39: KPIs related to Dissemination.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-DIS-1	Number of scientific papers in high-impact topic-specific journals	Scientific papers in high-impact topic-specific journals ≥10 (Audience > 200 persons)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-2	Number of scientific papers in high-impact conferences/workshops	Scientific papers in high-impact topic-conferences / workshops ≥30 (Audience > 500 persons)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-3	Number of technical publications/white papers	Technical publications / white papers ≥10 (Audience > 200 persons)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-4	Number of participations in symposia and industrial exhibitions	Participation in symposia and industrial exhibitions ≥3 (>20 new contacts made)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-5	Number of liaisons established with other research projects	Liaisons established with other research projects / consortia ≥5 (>5 common events)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-6	Number of Industry links and future investors interested	Industry links ≥25 (≥5 future investors interested)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-7	Number of standardization liaisons and WG/TC members	Standardization liaisons ≥3 (> 100 WG/TC members)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-8	Number of Open Call awareness online workshops	Open Call Awareness online workshops ≥4 (> 100 participants)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-9	Number of open online Scientific & Technical workshops and participants	Open online Scientific & Technical workshops ≥2 (> 200 participants)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-10	Number of open Strategic Impact workshops and participants	Open Strategic Impact workshops ≥4 (> 400 participants)	KPI introduced in the COP-PILOT Grant Agreement document
KPI-DIS-11	Number of showcasing events and participants	Showcasing Events ≥1 (> 500 participants)	KPI introduced in the COP-PILOT Grant Agreement document

2.11 Definition of KPIs related to Exploitation

Table 2-40 lists KPIs related to expected Exploitation outcomes throughout COP-PILOT.

Table 2-40: KPIs related to Exploitation.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-EXP-1	Number of individual exploitable plans	Individual exploitable plans identified	KPI introduced in the COP-PILOT Grant Agreement document
KPI-EXP-2	Number of individual exploitation assets	Individual exploitation assets designed	KPI introduced in the COP-PILOT Grant Agreement document
KPI-EXP-3	Number of technology-driven joint exploitation plans	Technology-driven joint exploitation plans designed	KPI introduced in the COP-PILOT Grant Agreement document
KPI-EXP-4	Number of business-driven joint exploitation plans	Business-driven joint exploitation plans designed	KPI introduced in the COP-PILOT Grant Agreement document
KPI-EXP-5	Number of different business models	Different business models evaluated	KPI introduced in the COP-PILOT Grant Agreement document
KPI-EXP-6	Number of final business and sustainability plans	Final business and sustainability plans designed	KPI introduced in the COP-PILOT Grant Agreement document

2.12 Definition of KPIs related to Sustainable Development Goals

Table 2-42 discusses some broad Sustainable Development Goals (SDGs) of the COP-PILOT project introduced in the project's GA. These goals are mapped to the SDG initiative as per [23].

Table 2-41: Broad Sustainable Development Goals for COP-PILOT.

COP-PILOT SDG	SDG Category	Relation to the SDG Initiative [23]
COP-PILOT develops an open collaborative platform and promotes interoperability and standardization, to enhance the infrastructure necessary for technological advancement, thus supporting sustainable industrialization and fostering innovation.	Sustainable industrialization	Mapped to SDG-9 Industry, Innovation, and Infrastructure [23]
COP-PILOT provides new opportunities for the provisioning of innovative smart city services and promoting cross-sector collaboration, thus contributing to the creation of more sustainable and resilient urban environments.	Sustainable and resilient urban environments	Mapped to SDG-11 Sustainable Cities and Communities [23]
COP-PILOT promotes the adoption of edge computing solutions and enhances resource utilization, thus supporting efforts to reduce carbon emissions and build a more sustainable future.	Reduce carbon emissions	Mapped to SDG-13 Climate Action [23]
COP-PILOT establishes strategic partnerships and promotes inclusivity within the edge computing industry, thus contributing to the broader goal of building effective partnerships to achieve the SDGs.	Building effective partnerships	Mapped to SDG-17 Partnerships for the Goals [23]
By reducing provisioning and deployment time for complex cross-sector applications from hours or days to less than 10 minutes, resulting in approximately a 98% reduction in idle resource consumption leading to an estimated reduction of climate change severity by 0,1%, COP-PILOT contributes directly to lowering energy consumption and minimizing CO_2 emissions associated with datacenter operations. This drastic reduction in idle resource consumption translates into a more efficient utilization of computing resources, thereby decreasing the energy required to power and cool datacenters.	Reduce idle resource consumption	Mapped to SDG-7 Affordable and clean energy [23]
The project's emphasis on automation and intelligent resource management enables optimized energy usage throughout the IoT-to-edge-to-core continuum, further reducing the environmental impact of computing activities	Reduce environmental impact of computing activities	Mapped to SDG- SDG-7 Affordable and clean energy [23]

By fostering the adoption of COP-PILOT technology, which may lead to a 30% reduction in OPEX for services (see KPI-ECO-6), the project indirectly promotes sustainable practices by encouraging the efficient use of resources and minimizing wastage	Efficient use of resources (minimize wastage)	Mapped to SDG-12 Responsible consumption and production [23] SDG-7 Affordable and clean energy [23]

Out of these broad SDGs, COP-PILOT defines some concrete KPIs related to sustainability. These KPIs are defined at the level of each Cluster, as different vertical sectors may approach sustainability from different perspectives. Table 2-42 lists KPIs related to expected Sustainable Development Goals throughout COP-PILOT's Cluster activities across 5 business sectors.

Table 2-42: Cluster-level KPIs related to Sustainable Development Goals.

KPI ID	KPI Name	KPI Description	KPI Standard Definition (reference to bibliography or grant agreement)
KPI-SDG-CL1-1	*	*	*
KPI-SDG-CL2-1 **Mapped to:** SDG 8 — Decent Work and Economic Growth SDG 12 — Responsible Consumption and Production	Productivity & Validation Performance	Measures the efficiency and sustainable resource use of the deployments by calculating the percentage of deployed devices that pass the integration tests. Captured through the evaluation of successful integrations, thereby minimizing waste and optimizing productive investments.	Aligned with economic growth (SDG 8) and sustainable production patterns (SDG 12) objectives. Linked to KV Productivity and KVI Validation Performance.
KPI-SDG-CL2-2 **Mapped to:** 'SDG 8 — Decent Work and Economic Growth 'SDG 9 — Industry, Innovation and Infrastructure	Market Readiness & Commercial Viability	Measures the project's technological advancement and potential for sustainable market entry by assessing the Technology Readiness Level (TRL) achieved. Captured through the evaluation of accepted metrics to ensure the solution reaches TRL7 by the end of the project, fostering viable and resilient innovation.	Aligned with fostering innovation (SDG 9), economic growth (SDG 8), and sustainable production (SDG 12). Linked to KV Commercial Viability and KVI Market readiness.

'SDG 12 — Responsible Consumption and Production			
KPI-SDG-CL1-3A **Mapped to** SDG 2 — Zero Hunger SDG 12 — Responsible Consumption and Production SDG 13 — Climate Action SDG 15 — Life on Land	Sustainable & Low-Impact Leafy Vegetable Production	Measures the aggregate reduction in environmental footprint of spinach cultivation and its associated supply chain through precision agriculture and smart logistics deployments. Covers reduction in chemical inputs (pesticides, herbicides), water use, and logistics-related carbon emissions across the full farm-to-fork value chain.	Aligned with the EU Farm-to-Fork Strategy target of 50% pesticide reduction and 20% fertiliser reduction by 2030 and the European Green Deal's agriculture decarbonisation objectives. Linked to KPI-VSS-CL3A-1, KPI-VSS-CL3A-3, KPI-VSS-CL3A-5, and KVI-VSS-CL3A-5.
KPI-SDG-CL3A-2 **Mapped to** SDG 8 — Decent Work and Economic Growth SDG 10 — Reduced Inequalities	Digital Inclusion & Decent Work in Contract Farming	Measures the degree to which COP-PILOT contributes to improved working conditions and inclusive access to digital tools for contracted farmers and agronomists in the Barba Stathis network. Captured through reduction in manual labour hours per farmer and per agronomist, and the number of contract farmers actively and independently using COP-PILOT-enhanced precision agriculture tools during the pilot.	Aligned with Horizon Europe's societal impact requirements and the EU Farm-to-Fork Strategy's commitment to rural digitalisation. Linked to KPI-SOC-CL3A-2 and KVI-VSS-CL3A-1.
KPI-SDG-CL3E-1 Mapped to: SDG 7 — Affordable and Clean Energy SDG 9 — Industry, Innovation and Infrastructure SDG 13 — Climate Action	Accelerating Renewable Energy Integration and Grid Decarbonisation	Measures the aggregate contribution of CL3E to clean energy availability and grid decarbonisation through optimised biogas electricity dispatch, reduced EV charger downtime, and AI-driven grid flexibility management. Covers increased utilisation of biogas as a dispatchable RES, reduction in diesel generator use during peak periods, and improved renewable energy penetration.	Aligned with the EU Green Deal's energy sector decarbonisation objectives and the REPowerEU plan. Linked to cluster-specific KPIs KPI-VSS-CL3E covering energy efficiency and RES integration outcomes.
KPI-SDG-CL4-1	Circular and Trustworthy IoT for Sustainable	Measures Cluster 4's contribution to sustainable vineyard operations through circular IoT sensor lifecycle management,	Aligned with sustainable infrastructure,

	Vineyard Operations	including sensor recovery, reuse and recycling, reduction of electronic waste, and trusted lifecycle traceability using euID wallet records	responsible production and resource use, and reduced environmental impact. Linked to KPI-SOC-CL4-1 and assessed through sensor recovery rate, waste reduction, lifecycle traceability completeness, and GDPR and data-sovereignty compliance

* Cluster 1 are evaluating societal and sustainability impact through KVIs supported by measurable proxy indicators, qualitative assessment, stakeholder feedback, and where relevant modelled estimates. Direct real-world impact metrics such as reduced accident rates or verified CO_2 reductions cannot be fully validated within a TRL6 testbed and should therefore be treated as expected post-project impacts, not as hard project-level KPIs.

3 A Holistic Evaluation of the COP-PILOT Impact

This section leverages the KPI/KVI evaluation tables defined in Sections 1.3 and 1.4 to evaluate each KPI and KVI defined across the twelve (12) categories in Section 2.

3.1 Impact on Global Project Objectives

3.1.1 KPI-GO-1.1a - Platform integration with Infrastructure Controllers

Table 3-1: KPI-GO-1.1a - Platform integration with Infrastructure Controllers.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1 (A Kubernetes cloud-native controller was already available, since the ACROSS EU project)	3 (Within the COP-PILOT context, Giter was developed to manage GitOps-driven infrastructure, and NaC controller was developed to manage NOKIA's 5G system)			≥3	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Compare the COP-PILOT platform's integration with infrastructure controllers with its predecessor platform by the ACROSS EU project	T3.2 integration points	DO integration report in T3.2	Periodically, before each evaluation milestone

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A, since additional infrastructure controllers are already in the post-development phase	N/A

3.1.2 KPI-GO-1.1b - Platform integration with NFVO

Table 3-2: KPI-GO-1.1b - Platform integration with NFVO.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	1			≥1	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Compare the COP-PILOT platform's integration with NFVO with its predecessor platform by the ACROSS EU project	T3.2 integration points	DO integration report in T3.2	Once before the M18 release

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

3.1.3 KPI-GO-1.1c - Platform integration with IoT platforms

Table 3-3: KPI-GO-1.1c - Platform integration with IoT platforms.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1 (P2CODE integrated only Orion-LD)	4 (COP-PILOT integrates also Scorpio, Stellio, and Eclipse Arrowhead)			≥2	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compare the COP-PILOT platform's integration with IoT platforms with those integrated by its predecessor platform by the P2CODE EU project		T3.3 platform components	IoT platform providers' report in T3.3		Once before the M18 release
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
FIWARE's financial insolvency could have affected this KPI			The project started early integration of platform components, thus 3 FIWARE platforms (Orion, Scorpio, and Stellio) where already integrated across 4 Clusters (except CL1 who use another IoT platform) by M12. FIWARE left the project on May 14, therefore the risk was completely mitigated		

3.1.4 KPI-GO-1.2a Standard interfaces support

Table 3-4: KPI-GO-1.2a - Standard interfaces support.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
18	28 (2 out of 3 BMP APIs by M18)	29 (3 out of 3 BMP APIs expected by M25)		≥20	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Number of standardized northbound APIs across all core platform components (BMP, ESO, DO, DM, SIF, and CI/CD platform) Compare the COP-PILOT platform's standard interfaces with those offered by its predecessor platform by the ACROSS EU project	3x BMP TMF APIs, 14 ESO/DO TMF APIs, 1x DO ETSI NFV SOL005 API, 1x DO GSMA GST, 7x DM ETSI NGSI-LD APIs, 3x SIF APIs	Core platform component owners report in T3.1-T3.5	Once before the M18 release

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
FIWARE's financial insolvency could have affected this KPI	The project started early integration of platform components, thus 3 FIWARE platforms (Orion, Scorpio, and Stellio) where already integrated and their standardized APIs were document at an early stage.

3.1.5 KPI-GO-1.2b - Telemetry APIs support

Table 3-5: KPI-GO-1.2b - Telemetry APIs support.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
3 (Prometheus, OpenTelemetry, and TMF628 Performance Mgmt.)	4 (new support of the TMF642 Alarm Mgmt. API)			>3	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**	
Compare the COP-PILOT platform's standard interfaces with those offered by its predecessor platform by the ACROSS EU project		Telemetry APIs of the core platform components (BMP, ESO, DO, DM, SIF, and CI/CD platform)	Core platform component owners report in T3.1-T3.5	Once before the M18 release	
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.6 KPI-GO-1.3 - Number of exposed service & resource APIs

Table 3-6: KPI-GO-1.3 - Number of exposed service and resource APIs.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
10 (ACROSS+P2 CODE platforms delivered 4x TMF Service Mgmt. APIs + 4x TMF Resource Mgmt. APIs + 1 TMF Telemetry API + 1 Policy API)	12 (+1 TMF Service Test API by the DO +1 Secret Management API by the ESO)			≥10	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compare the COP-PILOT service and resource APIs with those exposed by its predecessor platform by the ACROSS and the P2CODE EU projects		Service and resource APIs exposed by the ESO and DO orchestrators.	ESO and DO platform component owners report in T3.1 and T3.2		Once before the M18 release
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.7 KPI-GO-1.4 - Orchestration complexity

Table 3-7: KPI-GO-1.4 - Orchestration complexity.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>3

(ACROSS employed 2 orchestrators in Athens and one in Patras city)</td><td>9

(1x ESO and 8x DO instances across all Clusters)</td><td>14

(Expected by M25)</td><td></td><td>≥10</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Compare the COP-PILOT platform with its predecessor platform by the ACROSS EU project</td><td>Count the number of ESO and DO instances deployed across the central COP-PILOT testbed and all Cluster testbeds</td><td colspan="2">ESO portal peering view reports all DO instances under the ESO</td><td>Periodically done by the ESO as it sends heartbeat messages to all peered DO instances. If a DO appears offline, the instance disappears from the ESO's list of peered orchestrators</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
</table>

3.1.8 KPI-GO-1.5 - Response time for application-level reconfiguration at the edge

Table 3-8: KPI-GO-1.5 - Response time for application-level reconfiguration at the edge.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (This KPI was not evaluate by a previous version of the platform in the context of the ACROSS or P2CODE projects)	The PowerFleet edge service for temperature monitoring runs as a Kubernetes deployment in a k3s distribution. The hardware running that service is a Raspberry pi 5 located inside the outbound refrigerated truck. A new version of the service is applied with a rollout/restart of the deployment; that process needs to download and run the new container image. A new configuration could be faster if it stays in the same version as it doesn't need to download the container image. In case of a service version update time depends on the download time of the container image. In case of a reconfigure the time to rollout/restart without downloading is			<2 m	ACHIEVED

	under 2 minutes. The reported value excludes the container image download time, since that depends on the local network conditions and load; the measurement therefore reflects the rollout/restart of the deployment without downloading a new image.				

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Deploy a PowerFleet application component on the Raspberry Pi 5 + k3s node at the truck, issue a reconfiguration command via the local Domain Orchestrator (DO), and measure the time elapsed from command issue until the reconfiguration is applied.	Log files from the DO and the PowerFleet application	Extreme edge deployment in the context of CL3A PowerFleet application components on a logistics truck and measurement of the reconfiguration time	Once before the M18 release

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Procurement of the truck edge hardware (Raspberry Pi 5) could have delayed the measurement.	Mitigated — the Raspberry Pi 5 + k3s edge node was procured and deployed, and the reconfiguration-time measurement was completed ahead of the M18 release.

3.1.9 KPI-GO-1.6a - Response time for compute infrastructure reconfiguration

Table 3-9: KPI-GO-1.6a - Response time for compute infrastructure reconfiguration.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	N/A in this phase			<10 sec	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Calculate the required time from the issuing of a compute infrastructure reconfiguration request to its fulfilment	COP-PILOT Clusters offered compute infrastructure services	Clusters stakeholders report in T4.1	Periodically, before each evaluation milestone

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
The target value may not be achievable in every cluster, due to infrastructure heterogeneity	COP-PILOT clusters' infrastructure spans from energy-efficient, low-capacity compute nodes up to industry-grade nodes and virtualization stacks, rendering the target value at least partially achievable

3.1.10 KPI-GO-1.6b - Response time for network infrastructure reconfiguration

Table 3-10: KPI-GO-1.6b - Response time for network infrastructure reconfiguration.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>N/A</td><td>N/A in this phase</td><td></td><td></td><td><20 sec</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Calculate the required time from the issuing of a network infrastructure reconfiguration request to its fulfilment</td><td>COP-PILOT Clusters offered network infrastructure services</td><td colspan="2">Clusters stakeholders report in T4.1</td><td>Periodically, before each evaluation milestone</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">The target value may not be achievable in every cluster, due to infrastructure heterogeneity</td><td colspan="3">COP-PILOT clusters’ infrastructure spans from experimental laboratory network equipment up to carrier-grade networks, rendering the target value at least partially achievable</td></tr>
</table>

3.1.11 KPI-GO-2.1a - LLM impact on ordering time

Table 3-11: KPI-GO-2.1a - LLM impact on ordering time.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><td>Baseline Value (M1)</td><td>Measured Value – Initial Evaluation (M17)</td><td>Measured Value – Intermediate Evaluation (M25)</td><td>Measured Value – Final Evaluation (M33)</td><td>Target Value (M36)</td><td>Assessment Result</td></tr>
<tr><td>Several minutes</td><td>N/A in this phase</td><td></td><td></td><td><2 min</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><td colspan="2">Measurement Calculation Formula</td><td>Measurement Input Source</td><td colspan="2">Measurement Collection Process</td><td>Measurement Collection Frequency</td></tr>
<tr><td colspan="2">Calculate the required time from the initiation of catalog browsing to the submission of an order request. Compare the average ordering time with and without LLM assistance</td><td>BMP and ESO ordering logs; LLM-assisted ordering workflows</td><td colspan="2">COP-PILOT stakeholders report ordering execution times collected during pilot demonstrations and evaluation activities in T4.1</td><td>Periodically, before each evaluation milestone</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><td colspan="3">Identified Risk(s)</td><td colspan="3">Risk Mitigation Plan</td></tr>
<tr><td colspan="3">The target value may not be achievable for all service types due to differences in service complexity, external dependencies, and varying provisioning workflows. In addition, LLM recommendations may require human validation, increasing completion time.</td><td colspan="3">LLM-assisted automation primarily for standard and frequently requested services. Human oversight is maintained where necessary, while workflow optimization and prompt refinement are continuously applied to reduce ordering delays and maximize achievable time savings.</td></tr>
</table>

3.1.12 KPI-GO-2.1b - LLM impact on policy provisioning time

Table 3-12: KPI-GO-2.1b - LLM impact on policy provisioning time.

KPI across project evaluation phases						
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**	
Several minutes	N/A in this phase			<1 min	NOT ACHIEVED	
KPI Methodology						
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
Calculate the required time from the initial intention to modify a provisioned service to the successful submission of a policy adjustment request through ordering and/or inventory alteration.		BMP ordering and/or inventory logs	COP-PILOT stakeholders report policy enforcement times collected during pilot demonstrations and evaluation activities in T4.1		Periodically, before each evaluation milestone	
Risk Management						
Identified Risk(s)			**Risk Mitigation Plan**			
The target value may not be achievable for all service types due to differences in service capabilities, policy exposure, and the magnitude of adjustable parameters			LLM-assisted policy provisioning primarily captures			

3.1.13 KPI-GO-2.2 - Number of SLA violation forecasting schemes

Table 3-13: KPI-GO-2.2 - Number of SLA violation forecasting schemes.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	3			≥5	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compare the COP-PILOT platform's SLA violation schemes with its predecessor platform by the ACROSS EU project		Number of Closed-loop services that forecast SLAs in WP4	Each closed loop service reports how many different algorithms/schemes it employs for SLA forecasting		Once before the M18 release
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Closed-loop services are defined in D4.1 but not fully developed yet			Closed-loop service development will be concluded by the 3rd evaluation cycle (M33)		

3.1.14 KPI-GO-2.3 - SLA preservation time

Table 3-14: KPI-GO-2.3 - SLA preservation time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Several tens of minutes (via manual steps)	N/A in this phase Tforecasting + Treconfiguration ≤ 30 sec + Kubernetes scale API update time. Full end-to-end value pending validation measurement.			A few minutes	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
$T_{forecasting} + T_{reconfiguration}$		HPA+ closed-loop service	Run a validation scenario where HPA+ forecasts a resource-related SLA risk and triggers autoscaling. Record the timestamp of the forecast, the timestamp of the scaling decision, and the timestamp when Kubernetes applies the replica update. Calculate the total elapsed time.		At each HPA+ closed-loop execution during validation experiments
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Closed-loop services are defined in D4.1 but not fully developed yet			Closed-loop service development will be concluded by the 3rd evaluation cycle (M33)		

3.1.15 KPI-GO-2.4 - Eliminate human factors in SLA preservation

Table 3-15: KPI-GO-2.4 - Eliminate human factors in SLA preservation.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>Human factor only present in the initial SLA preservation request

(The ACROSS EU project managed to achieve this KPI at its final stage. It was demonstrated at ETSI ZSM PoC#16. Inherited by COP-PILOT)</td><td>Human factor only present in the initial SLA preservation request

Evidence from our ETSI ZSM PoC#16 Scenario #3B</td><td>Human factor only present in the initial SLA preservation request</td><td>Human factor only present in the initial SLA preservation request</td><td>Human factor only present in the initial SLA preservation request

→ (Zero-touch once the request is made)</td><td>ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Manual SLA preservation steps / Total SLA preservation steps</td><td>Human report</td><td colspan="2">Human report for manual steps + system report for automated steps</td><td>Periodic, in every new release of the platform</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
</table>

3.1.16 KPI-GO-2.5 - Amount of integrated Intelligence

Table 3-16: KPI-GO-2.5 - Amount of integrated Intelligence.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	50% - SLA forecasting intelligence implemented in HPA+, LLM-based service blueprint intelligence pending.			=100%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Implemented intelligence functions / 2 * 100		HPA+ code/docs and platform integration records	Check integration of LLM-based blueprint generation and SLA forecasting.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Full integration of both intelligence functions is pending.			Complete and validate HPA+ and LLM integration by M33		

3.1.17 KPI-GO-2.6a - SLA violation MAPE

Table 3-17: KPI-GO-2.6a - SLA violation MAPE.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>N/A</td><td>N/A in this phase</td><td></td><td></td><td>< 10%</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">MAPE = mean(|actual value - predicted value| / actual value) * 100</td><td>HPA+ prediction logs and measured workload/SLA metrics</td><td colspan="2">Compare HPA+ predicted values with actual measured values.</td><td>At each validation experiment</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">No validated prediction dataset yet.</td><td colspan="3">Collect HPA+ predictions and actual measurements during workload tests.</td></tr>
</table>

3.1.18 KPI-GO-2.6b - SLA violation prediction precision

Table 3-18: KPI-GO-2.6b - SLA violation prediction precision.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	N/A in this phase			> 80%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Precision = true SLA violation predictions / all SLA violation predictions * 100		HPA+ prediction logs and labelled SLA violation events	Compare predicted SLA violations with actual SLA violations.		At each validation experiment
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
No labelled SLA violation events yet.			Generate controlled workload tests and label actual SLA violations.		

3.1.19 KPI-GO-2.7 - Time buffer for timely prediction enforcement

Table 3-19: KPI-GO-2.7 - Time buffer for prediction enforcement.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	N/A in this phase			Anticipatory prediction between 2-5 seconds in advance	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Time buffer = expected SLA violation time - HPA+ predictive scaling decision time		HPA+ prediction logs, SLA violation timestamps	Run workload tests and compare when HPA+ predicts/scales with when the SLA violation would occur without scaling.		At each HPA+ evaluation cycle during validation experiments
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Buffer depends on sync period (static time interval where HPA+ runs a cycle), workload behaviour, and availability of SLA violation timestamps.			Use controlled workload tests with fixed sync period and recorded prediction/violation timestamps.		

3.1.20 KPI-GO-3.1 - Domain expansion time

Table 3-20: KPI-GO-3.1 - Domain expansion time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
5 min (In ACROSS the expansion starts from top-down)	5 min (Still using the ACROSS workflow)	 (New COP-PILOT workflow with enhanced security and automation)	 (New COP-PILOT workflow with enhanced security and automation)	< 5min (GA target value was 10min. Redefined now based on recent and great ACROSS EU project outcomes)	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compare the COP-PILOT domain expansion process with its predecessor platform by the ACROSS EU project		Systems logs from the ESO, DO, and SIF components during the execution of the expansion flow	Timestamp of the initial request for domain expansion substituted by the timestamp that marks the completion of the last expansion step.		Every time a new domain is added under the COP-PILOT platform.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
ACROSS already defines a solid domain expansion workflow. However, this workflow can be further improved, considering security aspects of domain owners.			Design a new domain expansion workflow that improves upon the existing one (implemented by the ACROSS project). This flow my consider that expansion starts from the domain owner who owns a private DO instance somewhere and initiates the "registration" to the ESO through the SIF, maintaining high security and trust along the way.		

3.1.21 KPI-GO-3.2 - Platform instance provisioning

Table 3-21: KPI-GO-3.2 - Platform instance provisioning.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
75 sec. (Baseline platform is ACROSS. Includes one manual step)	68 sec. (Using the new COP-PILOT CI/CD platform. Now the flow is fully automated)	 (Measured after pipeline optimisation)	 (Measured after pipeline optimisation)	≤ 75 sec. (Initial GA target value was 10min. Redefined now based on recent and great ACROSS EU project outcomes)	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compare the COP-PILOT platform instance provisioning time with its predecessor platform by the ACROSS EU project. The target platform instance is the Domain Orchestrator.		Systems logs from the CI/CD platform while deploying a new DO instance	Timestamp of the CI/CD pipeline trigger request for a new domain orchestrator substituted by the timestamp that marks the completion of this pipeline.		Every time a new domain orchestrator is deployed by the CI/CD platform.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.22 KPI-GO-3.3 - Domain data exposure time

Table 3-22: KPI-GO-3.3 - Domain data exposure time.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>N/A</td><td>N/A

at this phase</td><td>Avg:

CL1:
CL2:
CL3A:
CL3E:
CL4:</td><td>Avg:

CL1:
CL2:
CL3A:
CL3E:
CL4:</td><td><1 min</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">$T_{exposure}$ for every IoT device/data source in each Cluster</td><td>COP-PILOT Data Management (DM) platform components per cluster</td><td colspan="2">DM logs during data onboarding and exposure</td><td>Once upon every new data source onboarding</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">Some DM platform instances are not deployed in the Clusters</td><td colspan="3">Second period of the project will ensure this measurement is taken.</td></tr>
</table>

3.1.23 KPI-GO-3.4 - IoT device cardinality

Table 3-23: KPI-GO-3.4 - IoT device cardinality.

KPI across project evaluation phases						
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**	
Total: 100 CL1: 100 CL2: 0 CL3A: 0 CL3E: 0 CL4: 0	Total: 749 CL1: 400 CL2: 105 CL3A: 100 CL3E: 100 CL4: 44			> 200	ACHIEVED	
KPI Methodology						
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
$\Sigma_{\text{all clusters}}\ \Sigma_{\text{iots/cluster}}$		KPI-VSA-PIS-DEV-CNT-CL1+ KPI-VSA-PIS-DEV-CNT-CL2+ KPI-VSA-PIS-DEV-CNT-CL3A+ KPI-VSA-PIS-DEV-CNT-CL3E+ KPI-VSA-PIS-DEV-CNT-CL4	Refer to per cluster methodology		Refer to per cluster frequency	
Risk Management						
Identified Risk(s)			**Risk Mitigation Plan**			
Refer to all 5 Clusters' KPI-VSA-PIS-DEV-CNT-CLX risks			Refer to all 5 Clusters' KPI-VSA-PIS-DEV-CNT-CLX mitigation plans			

3.1.24 KPI-GO-4.1 - Clusters' cardinality

Table 3-24: KPI-GO-4.1 – Clusters' cardinality.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (These clusters did not exist before COP-PILOT)	4 (Although Cluster 3 is split in 2 parts, one for agriculture, another for Energy)	4	4	4	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
$\Sigma_{clusters}$		COP-PILOT GA	COP-PILOT GA Cluster establishment in Part B Section 1.2.2		Once (taken from the GA)
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.25 KPI-GO-4.2 - Cluster sites’ cardinality

Table 3-25: KPI-GO-4.2 – Cluster sites’ cardinality.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>Total: 0

CL1: 0
CL2: 0
CL3A: 0
CL3E: 0
CL4: 0</td><td>Total: 19

CL1: 5
CL2: 4
CL3A: 3
CL3E: 2
CL4: 5
Central: 1</td><td></td><td></td><td>> 15 cluster sites</td><td>ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">$\Sigma_{clusters} \Sigma_{cluster-sites}$</td><td>KPI-VSA-PIS-REG-CNT per clusters</td><td colspan="2">Refer to per cluster methodology</td><td>Refer to per cluster frequency</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">Refer to all 5 Clusters’ KPI-VSA-PIS-REG-CNT-CLX risks</td><td colspan="3">Refer to all 5 Clusters’ KPI-VSA-PIS-REG-CNT-CLX mitigation plans</td></tr>
</table>

3.1.26 KPI-GO-4.3 - Number of unique service blueprints

Table 3-26: KPI-GO-4.3 – Number of unique service blueprints.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Total: 0 Avg: 0 CL1: 0 CL2: 0 CL3A: 0 CL3E: 0 CL4: 0	Total: 36 **Avg: 7.2/Cluster** CL1: 8 CL2: 7 CL3A: 5 CL3E: 8 CL4: 6 Central: 2			>5/Cluster	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
$\Sigma_{\text{service-blueprints/cluster}}$ (for each Cluster)		ESO Service Catalog (specifications related to COP-PILOT UCs)	GET REST API call to the ESO Service Catalog or view of the ESO Catalogue on the ESO Portal		Once in every evaluation cycle
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.27 KPI-GO-4.4 - Service blueprints' application range

Table 3-27: KPI-GO-4.4 – Service blueprints' application range.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (OCs did not exist before COP-PILOT)	N/A in this phase (OC round#1 starts in M19)			3 blueprints/Cluster used by OC projects	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
$\Sigma_{\text{open-call-service-blueprints}}$ (for each Cluster)	ESO Service Catalog (specifications related to OCs)	GET REST API call to the ESO Service Catalog or view of the ESO Catalogue on the ESO Portal	Once in every evaluation cycle

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

3.1.28 KPI-GO-5.1a - Unique application components cardinality from UCs

Table 3-28: KPI-GO-5.1a – Unique application components cardinality from UCs.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>Total app. Components: -

Total apps: 12

CL1: 7
CL2: 0
CL3A: 2
CL3E: 2
CL4: 1

(These applications existed before COP-PILOT)</td><td>Total app. components > 40

Total apps: 34

CL1: 8
CL2: 7
CL3A: 5
CL3E: 8
CL4: 6

The above numbers correspond to <u>multi-component apps</u>, thus the total number of app. components goes beyond the target</td><td></td><td></td><td>≥40</td><td>ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">$\Sigma_{\text{app-components}}$
(for every application)
(for every cluster)</td><td>Service providers input per cluster</td><td colspan="2">COP-PILOT CI/CD pipeline that deploys each cluster application and counts number of deployed components</td><td>Periodic execution of the pipelines</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">Some applications are not final at early stages of the project, so the initial cycle report maybe off the reality</td><td colspan="3">This risk will be eliminated in the second phase of the project.</td></tr>
</table>

3.1.29 KPI-GO-5.1b - Unique application components cardinality from Open Calls

Table 3-29: KPI-GO-5.1b – Unique application components cardinality from OCs.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><td>Baseline Value (M1)</td><td>Measured Value – Initial Evaluation (M17)</td><td>Measured Value – Intermediate Evaluation (M25)</td><td>Measured Value – Final Evaluation (M33)</td><td>Target Value (M36)</td><td>Assessment Result</td></tr>
<tr><td>0</td><td>N/A in this phase

(OC round#1 starts in M19)</td><td></td><td></td><td>≥20</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><td colspan="2">Measurement Calculation Formula</td><td>Measurement Input Source</td><td colspan="2">Measurement Collection Process</td><td>Measurement Collection Frequency</td></tr>
<tr><td colspan="2">$\Sigma_{\text{OC-appl-components}}$</td><td>Number of application components reported by each Cluster</td><td colspan="2">Cluster interaction with OC projects within their cluster and report of this number to WP4 leader</td><td>Twice (at the deployment stage of each OC round)</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><td colspan="3">Identified Risk(s)</td><td colspan="3">Risk Mitigation Plan</td></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
</table>

3.1.30 KPI-GO-5.2 - Platform service components' cardinality

Table 3-30: KPI-GO-5.2 – Platform service components' cardinality.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	16			≥15	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
$\Sigma_{\text{closed-loop-services}}$		Intelligent, automation, and security platform services across 5 Clusters in WP4	Closed-loop service provider owners report (see D4.1 Section 4)		Once in every evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Some clusters have not defined any closed-loop services			Revisit closed-loop services in the second period of the project and provide updates in D4.2.		

3.1.31 KPI-GO-5.3 - Datasets' cardinality

Table 3-31: KPI-GO-5.3 – Datasets' cardinality (UCs and OCs).

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>Total: 0

CL1: 0
CL2: 0
CL3A: 0
CL3E: 0
CL4: 0</td><td>Total: 12

CL1: 0
CL2: 6
CL3A: 0
CL3E: 6
CL4: 0</td><td></td><td></td><td>≥20</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">$\Sigma_{datasets}$
(for every cluster)</td><td>Internal report by partners releasing these datasets</td><td colspan="2">Open dataset repository (e.g., Zenodo)</td><td>Once in every evaluation phase</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">Limited datasets' availability during early cluster activities, due to focus on other cluster aspects.

Possibility for some of these datasets to be closed</td><td colspan="3">In the second phase of the project we will ensure that datasets are reported.

All partners will be encouraged to publish their datasets on Zenodo or similar platform.</td></tr>
</table>

3.1.32 KPI-GO-6.1 - Market analyses' cardinality

Table 3-32: KPI-GO-6.1 – Market analyses' cardinality.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5			4	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count number of mark analysis conducted		Analysis per cluster in D7.2	N/A		Once at M18 of project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.33 KPI-GO-6.2 - Number of business cases defined

Table 3-33: KPI-GO-6.2 – Number of business cases defined.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5			11	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count Business cases identified		D7.2 and upcoming D7.4	N/A		At M18 and M36
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.1.34 KPI-GO-7.1 - Number of 3rd party submissions for integration

Table 3-34: KPI-GO-7.1 – Number of 3rd party submissions for integration.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	370			> 80	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of applicants in the Open Calls		Received applications	N/A		At M17 and M36
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2 Impact on the 5 COP-PILOT Vertical Sectors

3.2.1 Evaluation of the Mining Sector (Cluster 1)

3.2.1.1 Evaluation of Common Platform Indicators through Cluster 1-specific KPIs

For Cluster 1, the common VSA categories defined in Section 2.2 are evaluated through the relevant Cluster-specific KPIs defined in Section 2.3.1. The purpose is to avoid duplicative evaluation tables where the same evidence is already captured more accurately by Cluster 1's use-case-specific indicators. Therefore, Section 3 reports detailed evaluation tables only for the applicable Cluster 1 KPIs that provide evidence for the VSA categories. VSA categories or sub-indicators that are not applicable to the Cluster 1 TRL6 validation setup are not expanded into separate evaluation tables.

Table 3-35: Cluster 1 evaluation of common VSA categories through Cluster-specific KPI evidence.

VSA category	Cluster 1 evaluation status	Cluster 1 KPIs providing evaluation evidence
Level of Fragmentation	Evaluated through selected Cluster 1 interoperability/integration KPIs	See KPI-VSS-CL1-1.1, 1.2, 2.10, 3.4, 4.1, 4.8
Level of Security	Evaluated through defined secure service integration and auditability KPIs	See KPI-VSS-CL1-4.7, 4.8
Level of Automation	Evaluated through selected automation/provisioning/workload placement KPIs	See KPI-VSS-CL1-1.4, 2.2, 2.12, 3.2, 4.3, 4.5
Piloting Infrastructure Scale	Evaluated through selected scale and testbed coverage KPIs	See KPI-VSS-CL1-2.3, 2.8, 3.4, 4.1, 4.2
Network Availability and Performance	Not applicable	No Cluster 1 evaluation table required

3.2.1.2 Evaluation of Cluster 1-specific Business Indicators

Table 3-36: KPI-VSS-CL1-1.1 - Vendor interoperability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
3 Vendors supported (IMS, ESG, Silixa)	3			6 (+K-UTEC, +NMX,+TW)	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
Discrete count of (individual) seismic sensor array vendors successfully integrated, in demonstration or pilot	P22 ROC self-assessment	Successful integration determined as: dataset from vendor processed successfully (catalogue of seismic events with location and source parameters)	Status reviewed at each evaluation milestone
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
No dataset available for vendor X		Work with multiple new vendors in parallel	
Unforeseen technical barriers discovered		Early experimentation and iterative approach	

Table 3-37: KPI-VSS-CL1-1.2 – Simultaneous seismic sensor vendor interoperability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	1			≥2	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Discrete count of seismic sensor vendors simultaneously used for processing, in demonstration or pilot.		P22 ROC self-assessment	Count determined as: one or more seismic events processed with input waveform data from N seismic sensor vendors.		Status reviewed at each evaluation milestone
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
No dataset available with recorded waveforms from the same seismic event source, from two or more seismic sensor vendors			Keep synthetic data as an option in case ‘real’ data cannot be obtained		

Table 3-38: KPI-VSS-CL1-1.3 - Distributed compute (e2c).

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No	No			Yes	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Observation of processing solution distributed across edge/cloud with pre-processing logic at edge and final compound processing at cloud, in demonstration or pilot.		P22 ROC self-assessment	Achieved KPI defined as: Processing pipeline jobs successfully distributed across multiple (physically separate) compute nodes		Status reviewed at each evaluation milestone
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Unforeseen technical difficulties with distributed job orchestration			Use existing job orchestration platform (ColonyOS) for job distribution (vs building something new) Try early, use iterative approach		
Lack of resources/time to run dedicated test/demonstration with distributed compute setup			Combine distributed compute activities with more basic demonstration/pilot to minimize overhead.		

Table 3-39: KPI-VSS-CL1-1.4 - Compute dynamic/auto-scaling for SLA compliance.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No	Partial			Yes	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Observation of resources allocated during runtime, and job queue size (as a proxy for processing SLA compliance).	P22 ROC self-assessment	Achieved KPI defined as: Scaling up in response to a growing queue of jobs, scaling down (without loss) in response to short/empty queue of jobs. The growth trend and size of the job queue is interpreted as a proxy for SLA compliance.	Status reviewed at each evaluation milestone
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Unforeseen technical difficulties with autoscaler detection algorithms		Start with basic algorithms and iterate towards more sophisticated ones	
Unforeseen technical difficulties with job orchestration in autoscaling scenarios		Use existing job orchestration platform (ColonyOS) for job distribution (vs building something new) Try early, use iterative approach	

Table 3-40: KPI-VSS-CL1-2.1 - Rock bolt physical installation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
600 s	350 s			< 200 s	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Time from first drilling from operator to bolt with RBM-VX installed.		TAB personnel	Timed visual inspection		No set frequency - During customer installation
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Inability to measure due to lack of equipment allowed in mines or lack of TAB personnel present during installations.			Emulate installation internally.		

Table 3-41: KPI-VSS-CL1-2.2 - Rock bolt configuration time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
600 s	420 s			< 300 s	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Time to add all sensor information to ThingWaveNucleus platform		TAB personnel	Timed TAB personnel adding information		Before each evaluation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Lack of feedback from mine site			Discuss with multiple mines to ensure feedback		
Low end-user satisfaction			Involve end-users more to get better requirements		

Table 3-42: KPI-VSS-CL1-2.3 - Sensor infrastructure scale.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
100	400			> 1,000	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of sensors with data input to gateway with TAB system working		TAB personnel	Check number of sensors able to be seen on 2D map, 3D map, and in data-plot		Before each measurement period

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Not enough hardware available for test	Use of simulated sensors
To weak server CPUs	Work with RISE and ext. partners to gain access to more powerful servers
To weak backend infrastructure	Add support for load balancing and cluster processing

Table 3-43: KPI-VSS-CL1-2.4 - Collaborative support.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥1	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of partners with active data-streams		TAB together with partners	Check during initial integration that data can flow both ways		Measured at each integration
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Partners experience delays of generating data			Work with more partners to mitigate delays		
Poor data quality			Generate synthetic data and inject from partner		

Table 3-44: KPI-VSS-CL1-2.5 - Automatic tunnel inspection.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Manual human visits	Manual inspection report via Nucleus			> 100 per day	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Report function of platform OR measure number of reports generated when function is available		TAB personnel	Use of platform function		At integration & at each evaluation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Not enough events to test required amount of report value			Use simulated events		

Table 3-45: KPI-VSS-CL1-2.6 - Alarm detection latency.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Not previously implemented	30s			< 10 s	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Time from event reading being received at gateway to SMS alert to user	TAB personnel	Use demo bolt to generate event that triggers SMS alert	At each evaluation period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
No identifiable risks		None required	

Table 3-46: KPI-VSS-CL1-2.7 - Position update rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Every 10 min through manual human communication	Automated positional update every 10 minutes			One every 10 seconds	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Time between positional updates in TAB Nucleus platform for asset tracking tags		TAB personnel	Measure time between updates		At each evaluation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Doesn't regard the tag changing mesh network			Test update time when changing network for the tag		

Table 3-47: KPI-VSS-CL1-2.8 - Data reception performance.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1,000 packets/s	2,500			10,000 packets/s	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Packets sent from gateway to Nucleus per second		TAB personnel	Measure one minute and note difference in no. packet sent at start and end		Measured together with KPI-VSS-CL1-2.3
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Not enough hardware to test packet limit			Use simulated sensors		

Table 3-48: KPI-VSS-CL1-2.9 - System availability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
99.9%	99.9%			99.9%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
System uptime minus time for updates and maintenance		TAB personnel	Time system start up time, which gives an allowed number of restarts per year. Measure number of restarts		At each evaluation period
Risk Management					

Identified Risk(s)	**Risk Mitigation Plan**
Fluctuating patterns in updates can impact measurement	Use a longer timeframe for restart measurement to mitigate fluctuation in patterns
Hard to acquire test data	Use multiple instances and average the test data

Table 3-49: KPI-VSS-CL1-2.10 - Capability integration.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No	Manually integrated position			Yes	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Measure steps between no integration and fully integrated		TAB personnel	Check integration status in Nucleus platform		At each evaluation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
No identifiable risks			None required		

Table 3-50: KPI-VSS-CL1-2.11 - Underground asset visualisation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No	Basic data (elongation)			Advanced	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Measure steps between no asset visualization and advanced visualization with forecast		TAB personnel	Check visualization status in Nucleus platform		At each evaluation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Platform limitations hard to extend			Replace libraries and components with limitations		
Poor test parameters			Engage field experts to setup test environment		

Table 3-51: KPI-VSS-CL1-2.12 - Data processing distribution.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Manual at cloud	Manual at cloud			Real-time at edge	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Current status of edge processing integration		TAB personnel	Process data at current integration point		At each evaluation period

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Can take a long time between relevant data being received	Use simulated data
Lack of access to real-world data	Engage more mines to support us with getting real data to work on

Table 3-52: KPI-VSS-CL1-3.1 - Commissioning time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
7 hours	Not possible, will be measured in M25			< 2 hours	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
$t_{task}=t_{end}-t_{start}$		Developers or technicians measure the time manually	The assessment measures the time for the developers or technicians to set up and to commission the data pipelines		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The trained developer or technician is absent and replaced by a new resource which is not familiar with the task.			Perform training before the task execution.		
Improper device functionality			Test the device prior to commissioning and replace the device before the assessment.		

Table 3-53: KPI-VSS-CL1-3.2 - Commissioning automation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
(a) 6 (b) 8	Not possible, to be measured in M25			(a) 2 (b) 3	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Perform the updated work procedure and count the manual steps		Developer's assessment	Perform the commissioning of the device and data pipelines. Check the correctness of the commissioning by running the solution. If the solution performs correctly the new work procedure can be deemed as acceptable.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The trained developer is absent and replaced by a new resource which is not familiar with the task.			Perform training before the task execution.		
Improper device functionality			Test the device prior to commissioning and replace the device before the assessment.		

Table 3-54: KPI-VSS-CL1-3.3 - Data sample rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
100 Hz	To be measured in M25			500 Hz	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Number of samples divided by 1800 seconds	Start and stop timer and stored samples	The hardware is tested in a test bench. There the acquired data is stored and in parallel a secondary start and stop timer is run for a period of 30 minutes. The number of recorded samples is assessed and divided by the test period time.	Once per assessment period

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
The new hardware development is delayed, and the assessment cannot be executed	Delay the assessment and replan to perform the KPI assessment. Update the hardware development plan.

Table 3-55: KPI-VSS-CL1-3.4 - Scalability to large number of devices.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
3	Not successful at 50.			50	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Counting the number of unique device IDs		Check the number of simulated devices in the pre-production environment	Prior to the test, the simulated devices will be deployed in the pre-production environment. The data generation and streaming are initiated. Thereafter, the data flows are monitored by the developers and assessed for data loss. If no data loss is observed, the number of devices are deemed as achieved.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The developers fail to implement a correct data loss detections scheme, and the data loss cannot be assessed.			The data loss detection scheme needs to be thoroughly tested with mock-up data		

Table 3-56: KPI-VSS-CL1-3.5 - Belt conveyor monitoring setup time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
48 hours	N/A			24 hours	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

$ttask=tend-tstartttask=tend-tstart$	DevOps Time for the task from start to completion	The assessment measures the time for the developers to set up and to commission the industrial AI and the backend services. It is assumed that the intelligent scraper technology Hosch-iris Discover is already installed and the data flows from the site are established	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
The developer forgets to start the task execution or to stop the task execution when completed.		Remind the developers during the stand-ups that the correct task management is essential.	
The trained developer is absent and replaced by a new resource which is not familiar with the task.		Perform training before the task execution.	
Potential issue in the DevOps solution that prevents measurement		The developers should measure their time to performing the task manually to create redundancy.	

Table 3-57: KPI-VSS-CL1-4.1 - E2C testbed integration coverage.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	Limited UC integration demonstrated.			≥3 UC scenarios/services represented.	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of Cluster 1 UC services/workloads integrated or emulated in the UC1.4 E2C testbed.		Integration logs, deployment records, and service registry data from the UC1.4 testbed.	Services/workloads are validated through deployment and execution in the ColonyOS–Arrowhead environment. Integration is confirmed when services can be deployed, discovered, executed, and monitored in the testbed.		Once per assessment period.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

No risk identified	

Table 3-58: KPI-VSS-CL1-4.2 - Heterogeneous compute platform coverage.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Single-platform deployment environment	1			≥3 platforms	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of compute platforms integrated in the orchestration environment.		Deployment records, orchestration configuration files, and infrastructure monitoring systems.	Platforms are counted once connected to the orchestration framework and validated through workload deployment and execution.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Limited hardware availability			Use virtualized/simulated infrastructure where needed.		

Table 3-59: KPI-VSS-CL1-4.3 - Automated E2C continuum provisioning.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Manual provisioning and configuration of infrastructure components.	Limited provisioning automation demonstrated			Automated provisioning demonstrated	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Assessment of automated provisioning and setup of the E2C infrastructure.	Deployment scripts, CI/CD logs, and provisioning records.	Provisioning workflows are executed and validated by successful automated deployment of infrastructure and orchestration services.	Once per assessment period.
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

Table 3-60: KPI-VSS-CL1-4.4 - State reconciliation success rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Basic state reconciliation support in ColonyOS.	90% successful reconciliation in test scenarios.			≥95% successful reconciliation in test scenarios	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Fault and state drift scenarios are introduced, and reconciliation success is verified through automated recovery to the desired state.		ColonyOS orchestration logs and e2e test results.	Fault and state drift scenarios are introduced, and reconciliation success is verified through automated recovery to the desired state.		Once per assessment period.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
No risk identified					

Table 3-61: KPI-VSS-CL1-4.5 - Automated workload placement.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Static workload placement with manual scaling autoscaling	Autoscaling demonstrated in simulation environment.			Automated workload placement/autoscaling demonstrated	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Assessment of automated workload placement and autoscaling across edge/cloud resources.		Simulation output, orchestration logs, and benchmark results.	Autoscaling and workload placement scenarios are executed in the simulation environment and validated through workload migration and scaling behaviour.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Not all workloads may be suitable for migration between cloud and edge, and the cost of offloading may be high for certain workload.			Do not place or migrate workload between edge and cloud if the overhead is too large. Use the simulator to investigate offloading / autoscaling benefits.		

Table 3-62: KPI-VSS-CL1-4.6 - Fault recovery and task preservation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Partial automated workload recovery support.	Automated workload reassignment demonstrated.			Automated recovery demonstrated with zero committed-task data loss	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Assessment of automated workload recovery and task preservation following workload or executor failure.	End-to-end (e2e) test results and orchestration logs.	Failure and recovery scenarios are executed and validated through e2e and benchmark testing.	Once per assessment period.
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Workloads with external side effects may cause state inconsistencies during recovery.		Identify stateful workloads and apply rollback, retry, or application-level consistency handling mechanisms.	

Table 3-63: KPI-VSS-CL1-4.7 - Observability and auditability coverage.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Partial observability support for core orchestration components.	Improved logging and auditability support demonstrated.			100% of core orchestration components	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Coverage of logging, metrics, traces, and auditability support across core orchestration components.		ColonyOS source code, monitoring configuration, and orchestration logs.	Core orchestration components are reviewed to verify logging, metrics, tracing, and auditability support.		Once per assessment period.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
High observability data volumes may impact scalability and storage performance.			Apply scalable monitoring architecture and optimize log and metrics retention policies.		

Table 3-64: KPI-VSS-CL1-4.8 - Secure service interoperability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Limited secure inter-service communication support.	Initial secure service interoperability demonstrated.			100% of defined critical interactions.	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Share of services using secure communication, authentication, and authorization mechanisms.		Source code, security configuration, and orchestration logs.	Service interactions are reviewed to verify secure communication and authentication mechanisms.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Certain security mechanisms may introduce compatibility and performance limitations across heterogeneous platforms.			Use lightweight and platform-compatible cryptographic mechanisms where appropriate.		

Table 3-65: KPI-VSS-CL1-4.9 - UC1.4 testbed availability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No formally monitored availability baseline established.	>98% availability demonstrated.			≥99%	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
Available time / total time	RISE infrastructure monitoring system.	Data collection through Zabbix and Prometheus monitoring systems.	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Hardware failure		High availability is achieved by the underlying Kubernetes platform and/or ColonyOS.	
Power outage		The test bed is behind UPS with local energy storage, with the capacity to maintain operation for more than 2 hours of power outage.	
Communication interruption		There are two independent internet connections to the testbed.	

3.2.1.3 Converted Business Value for Cluster 1 (Business Impact Assessment)

Cluster 1 business impact is assessed through the Cluster-specific KVIs defined in Section 2.3.1 and the associated KPI-VSS-CL1 indicators reported in Section 3.2.1.2. At M17, the assessment is based on the available initial evaluation results. Several indicators show early progress, while others remain unchanged from baseline or are scheduled for measurement in later evaluation cycles.

For KVI-VSS-CL1-1.1, Improved real-time decision-making capabilities in critical situations, the associated indicators KPI-VSS-CL1-1.3 and KPI-VSS-CL1-1.4 do not yet provide measurable evidence of distributed seismic processing or dynamic compute scaling at M17. The expected business value therefore remains to be validated in later evaluation cycles.

For KVI-VSS-CL1-1.2, Flexible compute placement for seismic analytics, KPI-VSS-CL1-1.3 shows that distributed edge-to-cloud processing has not yet been demonstrated at M17. This value proposition remains relevant, but measurable evidence is expected during later validation phases.

For KVI-VSS-CL1-1.3, Higher resolution seismic monitoring, the associated indicators KPI-VSS-CL1-1.3 and KPI-VSS-CL1-1.4 do not yet show the required scalability improvements at M17. No business impact can therefore be concluded at this stage beyond the defined expected value.

For KVI-VSS-CL1-1.4, Vendor independence, KPI-VSS-CL1-1.1 remains at 3 supported vendors and KPI-VSS-CL1-1.2 remains at 1 simultaneously processed vendor. This indicates that the baseline capability is maintained, but the expected improvement in simultaneous multi-vendor interoperability has not yet been demonstrated.

For KVI-VSS-CL1-2.1, Cost efficiency and scalability of rock bolt deployments, the M17 results show clear initial progress. KPI-VSS-CL1-2.1 improved from 600 seconds to 350 seconds for physical installation, and KPI-VSS-CL1-2.2 improved from 600 seconds to 420 seconds for configuration. The target values have not yet been reached, but the results indicate reduced deployment effort compared with baseline.

For KVI-VSS-CL1-2.2, Cost efficiency of tunnel inspection, KPI-VSS-CL1-2.5 shows progress from manual human visits to manual inspection reporting via Nucleus. This is an initial step towards reducing manual inspection effort, although the target of more than 100 automated inspection reports per day has not yet been reached.

For KVI-VSS-CL1-2.3, Cost efficiency of lost asset localisation, KPI-VSS-CL1-2.7 shows a transition from manual human communication every 10 minutes to automated positional updates every 10 minutes. This provides initial evidence of reduced manual effort, while the final target of one update every 10 seconds remains to be validated.

For KVI-VSS-CL1-2.8, Extended functional lifetime of tracked assets, the M17 results provide early proxy evidence through reduced installation effort in KPI-VSS-CL1-2.1 and automated positional updates in KPI-VSS-CL1-2.7. The results support the expected value logic, but further validation is needed to assess effects on asset loss, recovery time and replacement needs.

For KVI-VSS-CL1-3.1, Improved and reliable onboarding and commissioning, the main associated indicators are scheduled for later assessment. KPI-VSS-CL1-3.1 and KPI-VSS-CL1-3.2 will be measured at M25, while KPI-VSS-CL1-3.4 was not successful at 50 devices at M17 and KPI-VSS-CL1-3.5 is not yet applicable. The expected business value is therefore not yet supported by sufficient M17 evidence.

For KVI-VSS-CL1-3.2, Higher accuracy in condition monitoring, KPI-VSS-CL1-3.3 is scheduled to be measured at M25. No M17 conclusion can therefore be drawn on the expected contribution of increased sample rates to improved condition monitoring accuracy.

For KVI-VSS-CL1-4.1, Reduced IT integration and platform management effort, the M17 results provide early evidence through limited automated provisioning in KPI-VSS-CL1-4.3, 90% successful state reconciliation in KPI-VSS-CL1-4.4, and improved logging and auditability support in KPI-VSS-CL1-4.7. These results indicate progress towards reducing manual platform management effort, although the final targets have not yet been reached.

For KVI-VSS-CL1-4.2, Scalable edge-to-cloud deployment capability for digital mines, the M17 results show limited UC integration in KPI-VSS-CL1-4.1, one integrated compute platform in KPI-VSS-CL1-4.2, limited provisioning automation in KPI-VSS-CL1-4.3, autoscaling demonstrated in simulation in KPI-VSS-CL1-4.5, and more than 98% testbed availability in KPI-VSS-CL1-4.9. This provides initial evidence of the edge-to-cloud deployment concept, while broader integration and scale remain to be demonstrated.

For KVI-VSS-CL1-4.3, Improved operational resilience of distributed mining applications, the M17 results provide early evidence through 90% successful reconciliation in KPI-VSS-CL1-4.4, autoscaling demonstrated in simulation in KPI-VSS-CL1-4.5, automated workload reassignment in KPI-VSS-CL1-4.6, improved observability in KPI-VSS-CL1-4.7, and more than 98% testbed availability in KPI-VSS-CL1-4.9. These results indicate a promising basis for resilience, but further validation is needed against the final targets.

For KVI-VSS-CL1-4.4, Secure and compliant industrial data and service integration, KPI-VSS-CL1-4.7 shows improved logging and auditability support, and KPI-VSS-CL1-4.8 shows initial secure service interoperability. This provides early evidence that secure integration capabilities are emerging, although full coverage of defined critical interactions remains to be validated.

For KVI-VSS-CL1-4.5, Reduced cloud dependency and transmission overhead, KPI-VSS-CL1-4.5 shows autoscaling demonstrated in a simulation environment. This supports the expected value logic of more flexible workload placement, but no quantified reduction in cloud dependency, data transfer or transmission overhead can yet be concluded at M17.

Overall, the M17 results provide partial but useful initial evidence for Cluster 1 business impact, especially in reduced rock bolt deployment effort, increased sensor infrastructure scale, improved operational monitoring, and early edge-to-cloud orchestration capabilities. The assessment will be complemented in later evaluation cycles as more functionality is implemented, additional KPI measurements become available, and further stakeholder feedback is collected.

3.2.2 Evaluation of the Smart City Sector (Cluster 2)

3.2.2.1 Evaluation of Common Platform Indicators

This section reports on the evaluation of common Platform KPIs as defined in Section 2.2, in the context of Cluster 2. These KPIs are classified in 5 categories, i.e., Level of Fragmentation (KPI-VSA-FRA), Level of Security (KPI-VSA-SEC), Level of Automation (KPI-VSA-AUT), Piloting Infrastructure Scale (KPI-VSA-PIS), and Network Availability & Performance (KPI-VSA-NAP), which appear in order below.

3.2.2.1.1 KPI-VSA-FRA-APP-CL2 - Application Proliferation per Process

Table 3-66: KPI-VSA-FRA-APP-CL2 – Application Proliferation per Process.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*2*			*5*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (applications that comprise an end-to-end process)		COP-PILOT platform application registry; CL2 architecture documentation	Enumeration of deployed applications per UC domain		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A high number of standalone applications or data silos can fragment data and hinder interoperability, limiting end-to-end automation in the COP-PILOT platform.			Reduce data silos by consolidating or federating isolated datasets		

3.2.2.1.2 KPI-VSA-FRA-ICI-CL2 - Integration Complexity Index

Table 3-67: KPI-VSA-FRA-ICI-CL2 – Integration Complexity Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
48	*6*			*5,8*	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Σ (integration weight × count)	COP-PILOT Cluster 2 platform integration diagrams	Enumeration of all cross-domain integrations per UC	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		*N/A*	

3.2.2.1.3 KPI-VSA-FRA-DDR-CL2 – Data Duplication Rate

Table 3-68: KPI-VSA-FRA-DDR-CL2 – Data Duplication Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*1.0*			*1.0*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (Number of systems storing the same data entity)/Total number of data entities		*PostgreSQL*	*Enumeration of systems storing each data entity*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Data loss due to a single point of failure (data currently relies on a single PostgreSQL instance with no redundancy).			*Deploy the planned backup database. This will ensure data availability and help achieve the KPI target value (2.0).*		

3.2.2.1.4 KPI-VSA-FRA- DI²-CL2 – Data Interoperability Index

Table 3-69: KPI-VSA-FRA- DI²-CL2 – Data Interoperability Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*1*			*1*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DI^2 = Σ (data entities represented using a standardised data model) / Σ (total number of data entities)		*FIWARE Orion-LD context broker entity catalogue*	*Audition of all data entities across CL2 systems and identification those exposed via NGSI-LD; ratio computed against total entity count*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low level of compliance with standardized data models (e.g., NGSI-LD) may lead to reduced interoperability and fragmented data flows across the platform			*Increase alignment with standardized data models by ensuring that data entities are structured using NGSI-LD or equivalent standards, improving interoperability and enabling consistent data exchange across systems.*		

3.2.2.1.5 KPI-VSA-FRA-ETC-CL2 – End-to-End Traceability Completeness

Table 3-70: KPI-VSA-FRA-ETC-CL2 – End-to-End Traceability Completeness.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*100%*			*100%*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
ETC = Fully traceable records / Total records		*PostgreSQL*	*Verification of timestamp presence and FIWARE context chain for each of all Cluster 2 data entities*		*Once per assessment period*

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Low traceability completeness may result in fragmented or missing records, reducing data reliability and making it harder to detect patterns, validate processes, and support accurate decision-making.	*Improve traceability by ensuring continuous and complete capture of operational data across systems, using integrated and standardized mechanisms to consolidate records and enhance visibility throughout the end-to-end workflow.*

3.2.2.1.6 KPI-VSA-FRA-TFI-CL2 - Total Fragmentation Index

Table 3-71: KPI-VSA-FRA-TFI-CL2 – Total Fragmentation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
14,65	*2,55*			*<3,39*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TFI formula: 0.3 x Normalized (APP) + 0.3 x Normalized (ICI) + 0.15 x Normalized (DDR) + 0.15 x (1 - DI2) + 0.1 x (1 – ETC)		*Computed from Tables KPI-VSA-FRA-APP-CL2, KPI-VSA-FRA-ICI-CL2, KPI-VSA-FRA-DDR-CL2, KPI-VSA-FRA-DI2-CL2, and KPI-VSA-FRA-ETC-CL2*	*The TFI is calculated using the weighted formula above, combining the five individual fragmentation KPIs collected through their respective methods.*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A high TFI score indicates significant fragmentation across systems and data layers, which may lead to inconsistent data, limited interoperability, and reduced ability to perform reliable end-to-end operations and analysis.			Reduce fragmentation by consolidating systems, standardizing data models, and improving traceability to progressively lower the TFI score and ensure more integrated, consistent, and interoperable platform operations.		

3.2.2.1.7 KPI-VSA-SEC-FED-CL2 - Federation Index

Table 3-72: KPI-VSA-SEC-FED-CL2 – Federation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*0.31*			*1*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
FED formula: Number of components using IAM / Total number of components		*CL2 architecture documentation*	*Enumeration of all CL3E components; classification of each component as protected or not*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			*N/A*		

3.2.2.1.8 KPI-VSA-SEC-E2E-API-PROT-CL2 - End-to-end API protection Index

Table 3-73: KPI-VSA-SEC-E2E-API-PROT-CL2 – End-to-end API protection Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*0.33*			*1*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-API-PROT formula: Σ (Number of application APIs protected by gateway or service mesh) / Total number of application APIs in end-to-end process		*CL2 architecture documentation*	*Verification of protection mechanism for each API interface across all CL2 domains*		*Once per assessment period*
Risk Management					

Identified Risk(s)	Risk Mitigation Plan
Significant number of APIs are not protected, increasing exposure to security vulnerabilities.	*Increase API protection coverage applying consistent security mechanisms such as access control, and request validation across all end-to-end interactions.*

3.2.2.1.9 KPI-VSA-SEC-E2E-API-AUTH-CL2 - End-to-end API authentication Index

Table 3-74: KPI-VSA-SEC-E2E-API-AUTH-CL2 – End-to-end API authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*0.31*			*1*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-API-AUTH formula: Σ (Number of application APIs with authentication or authorization) / Total number of application APIs in end-to-end process		*CL2 architecture documentation*	*Verification of protection mechanism for each API interface across all CL2 domains*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Significant number of APIs are not protected, increasing exposure to unauthorized access.			*Increase API protection coverage applying consistent security mechanisms as authentication, and request validation across all end-to-end interactions.*		

3.2.2.1.10 KPI-VSA-SEC-E2E-EXT-AUTH-CL2 - End-to-end outbound Authentication Index

Table 3-75: KPI-VSA-SEC-E2E-EXT-AUTH-CL2 – End-to-end outbound Authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*0*			*1*	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
E2E-EXT-AUTH formula: Σ (Number of authenticated calls to external/cross-domain systems) / Total number of calls to external systems	SIF connection logs and identity policy configuration	Enumeration of all cross-domain boundary connections; verification that each connection passes through SIF with valid certificate-based mutual authentication	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		*N/A*	

3.2.2.1.11 KPI-VSA-SEC-E2E-EV-LOG-CL2 – End-to-end Security event logging index

Table 3-76: KPI-VSA-SEC-E2E-EV-LOG-CL2 – End-to-end Security event logging index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*1*			*1*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
E2E-EV-LOG formula: Σ (Number of security events centrally logged/monitored) / Total number of security events	*Per-domain logs (for local logging verification)*	*Assessment of logging architecture*		*Once per assessment period*	
Risk Management					
Identified Risk(s)		**Risk Mitigation Plan**			
A low E2E-EV-LOG value indicates that security events are not consistently logged or centrally monitored, reducing visibility into incidents and limiting the ability to detect and respond to security threats in a timely manner.		*Improve logging coverage by ensuring that all security events are captured and centrally monitored across systems, enabling consistent auditability, detection, and response throughout the end-to-end process*			

3.2.2.1.12 KPI-VSA-SEC-DATA-ENC-CL2 - Sensitive data encryption Index

Table 3-77: KPI-VSA-SEC-DATA-ENC-CL2 – Sensitive data encryption Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*0.31*			*1*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DATA-ENC formula: Number of encrypted data operations / Total number of data operations		*Components that encrypt data transactions.*	*Classification of each data operation as encrypted or unencrypted*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low DATA-ENC value indicates that sensitive data is not consistently encrypted at rest or in transit, increasing the risk of data exposure and unauthorized access.			*Ensure that all sensitive data is protected using encryption mechanisms both at rest and in transit, applying consistent cryptographic controls across all data operations to improve overall data security.*		

3.2.2.1.13 KPI-VSA-SEC-TSI-CL2 - Total Security Index

Table 3-78: KPI-VSA-SEC-TSI-CL2 – Total Security Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*35%*			*100%*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TSI formula: 0.2 x FED + 0.2 x E2E-API-PROT + 0.2 x E2E-API-AUTH + 0.1 x E2E-EXT-AUTH		*Other KPIs*	*Mapping of the TSI score to the corresponding NIST Cybersecurity Framework maturity tier*		*At each evaluation phase*

+ 0.1 x E2E-EV-LOG + 0.2 x DATA-ENC			
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		*N/A*	

3.2.2.1.14 KPI-VSA-SEC-TSI-NIST-CL2 – Total Security Index by NIST

Table 3-79: KPI-VSA-SEC-TSI-NIST-CL2 – Total Security Index by NIST.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*2*			*5*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TSI-NIST score in [0, 5] scale (0 – Non-existent, 1 – Initial, 2 – Basic, 3 – Defined, 4 – Managed, 5 – Optimized)		*Based on KPI-VSA-SEC-TSI-CL2*	*Mapping of the TSI score to the corresponding NIST Cybersecurity Framework maturity tier*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			*N/A*		

3.2.2.1.15 KPI-VSA-AUT-TAI-CL2 – Total Automation Index

Depending on the scenario and field of business where automation needs to be quantified, one should define a set of stages where automation can be assessed individually. The following example shows how automation is quantified in a "Smart Sustainable IoT Solutions in Valencia" value chain in the context of Cluster 2. Table 3-80 defines the various stages of this value chain along with the typical set of tools used per stage.

Table 3-80: Automation stages for assessing Level of Automation in CL2.

Stage Number	**Stage Title**	**Typical tools used in stage**
1	Information collection – sensor/radar	Sensor's information
2	Information processing (ETL)	Custom development
3	Information collection – Context Broker	NGSI info data – Orion – Scorpio

4	Information persistence, storage in database	PostgreSQL
5	Rule engine – information reception and analysis	Draco
6	Rule engine – triggering order to OSL	Draco
7	OSL App – action execution	Custom development
8	Visualisation – Dashboards	Grafana
9	Data availability for third parties (Open Data)	CKAN

Next, Table 3-81 assigns an automation level from Table 2-14 to each automation stage.

Table 3-81: Automation levels per stages for assessing Level of Automation in CL2.

Stage Title	Automation level as per 3GPP
Information collection – sensor	5
Information processing (ETL)	5
Information collection – Content Broker	5
Information persistence, storage in database	5
Rule engine – information reception and analysis	5
Rule engine – triggering order to OSL	5
OSL App – action execution	5
Visualisation – Dashboards	5
Data availability for third parties (Open Data)	5

Moreover, Table 3-82 associates each automation stage with a weighted impact as not all stages exhibit the same importance in this specific value chain.

Table 3-82: Impact weight per stage for assessing Level of Automation in CL2.

Stage Title	Impact Weight
Information collection – sensor	5*
Information processing (ETL)	5*
Information collection – Content Broker	5*
Information persistence, storage in database	5*
Rule engine – information reception and analysis	5*
Rule engine – triggering order to OSL	5*
OSL App – action execution	5*
Visualisation – Dashboards	5*

Data availability for third parties (Open Data)	5*

* Weight is 5 for waste, radars, building count. Pending finish Port and Cross - user case

Based on the above information and the formula to measure "Total Automation Index" KPI, we derive the following values for this index in Table 3-83.

Table 3-83: KPI-VSA-AUT-TAI-CL2 – Total Automation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*60%***			*100%*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TAI formula: Σ(weight × level) / Σ(weight × max level)		*Manual calculation*	*Assignment of the current automation level per stage based on system logs and operational status at each assessment period.*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			*N/A*		

** Weight 5 is for waste management, traffic radars, building count. Pending to finish Port and Cross - use case

3.2.2.1.16 KPI-VSA-AUT-TAI-3GPP-CL2 – Total Automation Index by 3GPP

Having measured "Total Automation index" in Table 3-83, we use Table 2-19 to map this index to 3GPP automation levels, thus measure the equivalent KPI shown in Table 3-84.

Table 3-84: KPI-VSA-AUT-TAI-3GPP-CL2 – Total Automation Index by 3GPP.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*3*			*5*	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
TAI-3GPP formula: Based on Table 2 19	*KPI-VSA-AUT-TAI-CL2*	*Table to map KPI-VSA-AUT-TAI-CL2 to KPI-VSA-AUT-TAI-3GPP*	*At each evaluation phase*
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		*N/A*	

3.2.2.1.17 KPI-VSA-PIS-COV-CL2 - Total covered area

Table 3-85: KPI-VSA-PIS-COV-CL2 – Total covered area.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*61,2*			*61,2*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (IoT domain area)		*km² of each of Cluster 2 IoT domain areas*	*Manual measurement of IoT device deployment footprint per domain*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low COV value indicates limited IoT domain coverage, which may lead to incomplete data collection and reduced visibility across the monitored environment.			*Increase the covered IoT area by expanding deployments across additional domains, ensuring broader data capture and improved representativeness of the overall system.*		

3.2.2.1.18 KPI-VSA-PIS-REG-CNT-CL2 - Geographic dispersion

Table 3-86: KPI-VSA-PIS-REG-CNT-CL2 – Geographic dispersion.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*4*			*4*	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Addition number of distinct geographic regions in your cluster	*Count of different geographic regions*	*Manual measurement of geographic regions*	*At each evaluation phase*
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		*N/A*	

3.2.2.1.19 KPI-VSA-PIS-DOM-CNT-CL2 - Domain count

Table 3-87: KPI-VSA-PIS-DOM-CNT-CL2 – Domain count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*2*			*2*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
Number of administrative domains in your cluster. Each domain has an OSL instance to be considered a domain	*Count of different domains having OSL instances*	*Manual measurement of domain areas*		*At each evaluation phase*	
Risk Management					
Identified Risk(s)		**Risk Mitigation Plan**			
A low DOM-CNT value indicates limited participation of administrative domains, which may reduce interoperability and limit the ability to validate cross-domain integration and collaboration scenarios.		*Increase the number of participating administrative domains by onboarding additional stakeholders and systems or ensuring broader cross-domain interaction to improve scalability of the overall platform.*			

3.2.2.1.20 KPI-VSA-PIS-DEV-CNT-CL2 – Device count

Table 3-88: KPI-VSA-PIS-DEV-CNT-CL2 – Device count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*105*			*135*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (device count × weight) *DEV-CNT Weights* *Simple sensor = 1* *Smart sensor = 2* *Gateway = 5* *5G cell = 8* *Edge compute node = 10* *Cloud compute node = 15*		*Number of devices and infrastructure in use.*	*Sum of number of devices taking into account their type and weight.*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low DEV-CNT value indicates limited device deployment or insufficient infrastructure capacity, which may reduce data availability, processing capability, and overall system scalability.			*Increase the number (and diversity if needed) of deployed devices across domains, ensuring sufficient coverage and capacity to support scalable data collection, processing, and service delivery.*		

3.2.2.1.21 KPI-VSA-PIS-APP-CNT-CL2 – Application count

Table 3-89: KPI-VSA-PIS-APP-CNT-CL2 – Application count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
6	*7*			*7*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Sum of number of applications in Cluster	*Applications developed and available*		*Count of applications developed and in use*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low APP-CNT value indicates a limited number of applications in the cluster, which may reduce functional coverage and limit the ability to support diverse end-to-end processes across domains.			*Increase the number of applications/use cases by onboarding additional services across domains, ensuring broader functionality and improved support for integrated end-to-end operations.*		

3.2.2.1.22 KPI-VSA-PIS-PROTO-CNT-CL2 - IoT Protocol diversity

Table 3-90: KPI-VSA-PIS-PROTO-CNT-CL2 – IoT Protocol diversity.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*5*			*5*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Sum of number of communication protocols in use	*Communication protocols in use*		*Count of communication protocols used in Cluster 2*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Target value could be modified by using more communication protocols.	*All communication protocols must be compatible with Cluster.*

3.2.2.1.23 KPI-VSA-PIS-TIS-CL2 - Total Infrastructure Scale Index

Table 3-91: KPI-VSA-PIS-TIS-CL2 – Total Infrastructure Scale Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	*6,26*			*6,36*	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
log10(COV x REG-CNT x DOM-CNT x DEV-CNT x APP-CNT x PROTO-CNT)		*Other KPIs*	*Mapping of the previous KPIs into calculation formula*		*At each evaluation phase*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			*N/A*		

3.2.2.1.24 KPI-VSA-NAP-AV-CL2 - Network availability

Table 3-92: KPI-VSA-NAP-AV-CL2 – Network availability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	99,86%			>99%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Direct extraction of statistics from the ping utility. For availability: (Received packets / Transmitted packets) * 100		Console output from the ping network utility executed from a terminal on	At each evaluation phase		Continuous during the testing and validation windows.

	the 5G network targeting the radar's IP address.		
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Line of Sight (LoS) obstruction of the 5G signal caused by vessels passing between the antenna and the radar, which may lead to temporary connection drops or micro-outages		The radar equipment utilizes stored data locally during signal interruptions and automatically retransmits the information once the 5G link is restored, ensuring zero data loss. 100% uninterrupted physical availability would only be feasible via a fiber-optic link	

Table 3-93: KPI-VSA-NAP-LAT-CL2 – Network latency.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	15,979 ms			<100 ms	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Direct extraction of statistics from the ping utility. For latency: Average Round Trip Time (avg rtt) in milliseconds.		Console output from the ping network utility executed from a terminal on the 5G network targeting the radar's IP address.	Execution of continuous and automated ping command sequences from the 5G network to the radar, gathering and logging the statistical summary generated at the end of the run		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Line of Sight (LoS) obstruction of the 5G signal caused by vessels passing between the antenna and the radar, which may lead to temporary connection drops or micro-outages			The radar equipment stores data locally during signal interruptions and automatically retransmits the information once the 5G link is restored, ensuring zero data loss. 100% uninterrupted physical availability would only be feasible via a fiber-optic link		

Table 3-94: KPI-VSA-NAP-RATE-CL2 – Network delivery rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	130 Mbps			>20 Mbps	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Extraction of the receiver 'Bitrate' metric from the iperf3 tool. Calculated exactly as defined: Bits received at platform ingress / observation time (60 seconds), expressed in Megabits per second (Mbps).		Console output and network performance logs generated by the iperf3 utility.	Execution of an active TCP bandwidth measurement test using iperf3 configured in reverse mode (-R) for a 60-second duration (-t 60).		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Line of Sight (LoS) obstructions by passing vessels or severe weather reducing the available 5G uplink bandwidth.			Massive safety margin. The demonstrated network capacity (130 Mbps) far exceeds the radar's actual target requirements (~20 Mbps).		

Table 3-95: KPI-VSA-NAP-JITTER-CL2 – Network jitter.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	1,572 ms			<2 ms	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Direct extraction of the Jitter metric provided by the iperf3 network		Console output and statistical summary from the iperf3	Execution of an automated iperf3 UDP bandwidth test (configured		At each evaluation phase

testing tool. The tool calculates the smoothed mean of differences between consecutive transit times during a UDP test.	utility (running in UDP client mode) executed from a terminal on the 5G network targeting the radar's IP address.	over a 60-second duration) from the 5G network to the radar.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Fluctuations in the 5G wireless environment, transient network congestion, or partial Line of Sight (LoS) obstructions (e.g., moving vessels) can cause inconsistent packet delivery times, resulting in high jitter.		The receiving system and the radar utilize local buffering to absorb delivery delays, smoothing out the data stream.	

Table 3-96: KPI-VSA-NAP-REL-CL2 – Network reliability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	100,00%			>99,9%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Directly derived from the Packet Delivery Ratio (PDR), which is the mathematical inverse of Packet Loss. Formula: Network Reliability (%) = 100% - Packet Loss (%). It represents the percentage of sent network layer packets successfully delivered within the protocol's timeout constraint.		Console output and network statistics generated by iperf3.	Execution of active network telemetry tests. The testing utility tracks the exact number of packets transmitted by the sender versus the number successfully acknowledged by the receiver. A 0% packet loss directly confirms a 100% successful packet delivery ratio.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Transient network congestion causing packets to arrive late, exceeding the targeted service's time constraint.	Application of private 5G Quality of Service (QoS) profiles tailored for industrial IoT, ensuring priority routing and minimal queuing delay for sensor traffic.

Table 3-97: KPI-VSA-NAP-PLR-CL2 – Network packet loss.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	0%			<0,01%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Direct extraction of the Packet Loss metric provided by the iperf3 network testing tool. Calculated mathematically as: (Lost Datagrams / Total Transmitted Datagrams) * 100, expressed as a percentage.		Console output and final statistical summary from the iperf3 utility (running in UDP client mode) executed from a terminal on the 5G network targeting the radar's IP address.	Execution of an automated iperf3 UDP bandwidth test (configured over a 60-second duration) from the 5G network to the radar. The tool actively monitors the stream, counting the total number of UDP datagrams transmitted and successfully received, identifying any missing packets.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Fluctuations in the 5G wireless environment, transient network congestion, or partial Line of Sight (LoS) obstructions (e.g., moving vessels) can cause packets to be dropped in transit.			The receiving system and the radar utilize local buffering to absorb delivery delays, smoothing out the data stream.		

Table 3-98: KPI-VSA-NAP-RSRP-CL2 – RSRP.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial**	**Measured Value – Intermediate**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**

	Evaluation (M17)	Evaluation (M25)			
N/A	-73,65 dBm			<-90 dBm	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Statistical aggregation: Median (50th percentile) of the samples captured in the coverage area during the drive test		Log files and trace data generated using the Rohde & Schwarz ROMES drive test tool, with the TSMA6 RF scanner	A drive test was conducted along a predefined route within the target coverage area. A vehicle equipped with a 5G scanner and Rohde & Schwarz ROMES measurement software was used, which continuously recorded network parameters (RSRP, RSRQ, SINR) via GPS-geolocated traces.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Risk 1: Measurement equipment failure (ROMES software crash, loss of GPS signal, laptop battery failure). **Risk 2:** Inability to access planned routes due to blocked access caused by lack of permissions.			**For Risk 1 (Equipment):** Pre-trip verification and checklist of hardware/software (batteries, licenses, calibration) before starting the route. Automatic log saving to prevent data loss. **For Risk 2 (Routes):** Design of pre-approved alternative routes and scheduling flexibility to postpone measurements		

Table 3-99: KPI-VSA-NAP-RSRQ-CL2 – RSRQ.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	-10,42 dB			<-12 dB	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Statistical aggregation: Median (50th percentile) of the samples captured in the coverage area during the drive test		Log files and trace data generated using the Rohde & Schwarz ROMES drive	A drive test was conducted along a predefined route within the target coverage area. A vehicle equipped with a 5G scanner and Rohde & Schwarz ROMES measurement software was used, which continuously		At each evaluation phase

	test tool, with the TSMA6 RF scanner	recorded network parameters (RSRP, RSRQ, SINR) via GPS-geolocated traces.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Risk 1: Measurement equipment failure (ROMES software crash, loss of GPS signal, laptop battery failure). **Risk 2:** Inability to access planned routes due to blocked access caused by lack of permissions.		**For Risk 1 (Equipment):** Pre-trip verification and checklist of hardware/software (batteries, licenses, calibration) before starting the route. Automatic log saving to prevent data loss. **For Risk 2 (Routes):** Design of pre-approved alternative routes and scheduling flexibility to postpone measurements	

Table 3-100: KPI-VSA-NAP-SINR-CL2 – SINR.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	13,74 dB			>13dB	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Statistical aggregation: Median (50th percentile) of the samples captured in the coverage area during the drive test		Log files and trace data generated using the Rohde & Schwarz ROMES drive test tool, with the TSMA6 RF scanner	A drive test was conducted along a predefined route within the target coverage area. A vehicle equipped with a 5G scanner and Rohde & Schwarz ROMES measurement software was used, which continuously recorded network parameters (RSRP, RSRQ, SINR) via GPS-geolocated traces.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Risk 1: Measurement equipment failure (ROMES software crash, loss of GPS signal, laptop battery failure). **Risk 2:** Inability to access planned routes due to blocked access caused by lack of permissions.			**For Risk 1 (Equipment):** Pre-trip verification and checklist of hardware/software (batteries, licenses, calibration) before starting the route. Automatic log saving to prevent data loss. **For Risk 2 (Routes):** Design of pre-approved alternative routes and scheduling flexibility to postpone measurements		

3.2.2.2 *Evaluation of Cluster 2-specific Business Indicators*

Table 3-101: KPI-VSS-CL2-1 – Traffic state classification accuracy.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	80%			95%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(received_measurements/ expected_measurements)*100		Traffic Radars	Periodic cross-checking of traffic state reported by the radars with the actual state verified by collocated camera stream		At each evaluation stage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Incorrect traffic state threshold definition			Fine tuning traffic state thresholds		

Table 3-102: KPI-VSS-CL2-2 – Berthing detection accuracy.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	80%			100%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Detected berths / Total berths within measurement period		Berthing Assistance Radars	Berthing events are reported by the radars. Using port schedule and human verification, it can assess whether the report was correct or not		At each evaluation stage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Wrong thresholds selected for berthing event identification	Fine tuning berthing thresholds

Table 3-103: KPI-VSS-CL2-3 – Berthing detection false positive rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	15%			0%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
False positive reported berthing events / Total berthing events reported		Berthing Assistance Radars	Berthing events are reported by the radars. Using port schedule and human verification, it can assess whether the report was correct or not		At each evaluation stage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Wrong thresholds selected for berthing event identification			Fine tuning berthing thresholds		

Table 3-104: KPI-VSS-CL2-4 – HCHO Real-time Monitoring Coverage.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	60%			100%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(Number of sensors actively transmitting data within the expected reporting interval / Total number of deployed sensors) × 100. A		UPV Orion Context Broker (AirQualityObserved NGSI-LD entities, ch2o property and observation timestamps);	Automated verification of per-sensor data freshness via NGSI-LD entity queries to the UPV OrionCB, checking the latest observation timestamp per sensor against the expected 1-hour reporting		At each evaluation stage

sensor is considered "actively transmitting" if at least one valid data message has been received within the last 24 hours.	Telefónica Smart City platform (device status and data visualisation).	cadence; cross-checked through the Telefónica Smart City platform dashboards. Results logged and reviewed by the technical team.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
(1) Signal propagation issues in the industrial environment (metallic structures, interference) preventing sensor-to-gateway communication; (2) gateway failure causing loss of connectivity for all sensors.		Per-sensor signal quality assessment after deployment, with reconfiguration procedures for sensors with poor connectivity (already applied at M17); gateway health monitoring with remote diagnostics and on-site intervention protocol.	

Table 3-105: KPI-VSS-CL2-5 – Waste Threshold Alerts Notified.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0,00%	100 %			100%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of alerts delivered / Total number of threshold exceedances detected) × 100		Dual data extraction: 1) IoT platform database logs recording every instance a smart bin's telemetry exceeds the filling threshold, and 2) Dispatch receipts from the COP-PILOT Multi-Modal Notification Service.	UPV Orion Context Broker (Waste Container entities — filling Level values vs. configured thresholds); COP-PILOT Multi-Modal Notification Service logs (alert generation and delivery records).		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Failure or latency in third-party notification gateways preventing the alert from reaching the external operator.	Possibility of leveraging the 'Multi-Modal' architecture to provide redundant delivery paths.

Table 3-106: KPI-VSS-CL2-6 – System uptime.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	99%			99%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
System Uptime (%) = [(Total Operating Time - Total Downtime) / Total Operating Time] * 100. The downtime accounts for any period where the platform was unresponsive.		Automated monitoring logs from the cloud infrastructure and the container orchestration platform.	Monitors of the status of all critical platform components.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Hardware failures, network outages, or power disruptions at the physical hosting facility leading to total server unavailability.			Hardware redundancy and uninterrupted power supply (UPS) protocols		

Table 3-107: KPI-VSS-CL2-7 – Ship detection accuracy.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	60%			100%	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Detected ships / Total number of ships	Maritim Traffic Radar	The reports of the maritim traffic radar are cross-checked against AIS and Portcalls data	At each evaluation stage
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Radar detection loop disconnection due to firmware errors		Correct firmware issues to ensure uptime	

Table 3-108: KPI-VSS-CL2-8 – Detection range.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	18 m			15 m	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Mean (distance of berthing start)		Berthing Assistance Radars	The distance at which the verified berthing events were reported as starting is averaged		At each evaluation stage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Possible incidence of false positive on the KPI calculation			Cross-checking reported berthing events to use for this KPI		

Table 3-109: KPI-VSS-CL2-9 – Water level radar measurement standard deviation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1-5 cm			1-2cm	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

clasic standard deviation formula	Water Level Radars	Days without flood event are used as a measure of the precision of the radar	At each evaluation stage
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Measurement drift due to environmental conditions		Firmware adaptations to obtain a more precise measurement	

Table 3-110: KPI-VSS-CL2-10 – Water level radar relative measurement error.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0,00%	<1%			<1%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(measurment_error/reference_value)*100		Water Level Radars	The measurements on days without flooding event are compared to the reference value in a relative manner to avoid the influence of the sensor height in error assessment		At each evaluation stage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Measurement drift due to environmental conditions			Firmware adaptations to obtain a more precise measurement		

Table 3-111: KPI-VSS-CL2-11 – Water level radar up time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	100%			100%	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(received_measurements/expected_measurements) *100	Water Level Radars	If no measurements are received in a period in which they are expected, the radar is considered down for that period	At each evaluation stage
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Battery Exhaustion		Battery Level reporting for preventive battery replacement	

Table 3-112: KPI-VSS-CL2-12 – HCHO Threshold Alerts Notified.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0 (closed-loop integration pending — Phase 2)			100%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of alerts generated by the COP-PILOT Multi-Modal Environmental Alerter upon HCHO threshold exceedance and successfully delivered to at least one registered recipient via the Multi-Modal Notification Service, over the evaluation		UPV Orion Context Broker (AirQualityObserved entities — ch2o values vs. configured thresholds); COP-PILOT Multi-Modal Environmental Alerter and Notification Service logs (alert	Automated logging of each threshold exceedance event and its corresponding notification delivery status; periodic reconciliation between OrionCB observation data and alerter/notification logs to verify that every exceedance produced a delivered alert. End-to-end alert tests with controlled threshold values to validate		Continuous event-based logging; KPI consolidated and reported monthly, and at each evaluation milestone (M25, M36). Not measurable at M17 — closed-loop integration is scheduled for Phase 2 (M21).

period. Complementary ratio: (alerts delivered / threshold exceedances detected) × 100, with a target of 100%.	generation and delivery records).	the pipeline before live operation.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
(1) Real HCHO exceedances may be rare, leaving few or no live events to validate the alerting pipeline; (2) integration issues between OrionCB, the Environmental Alerter and the Notification Service delaying closed-loop operation.		Scheduled end-to-end tests with simulated threshold exceedances to validate the full alert chain regardless of real events; early integration testing of the closed-loop components during Phase 2, before operational rollout.	

Table 3-113: KPI-VSS-CL2-13 – Occupancy Data Completeness.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	100%			100%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(Number of data messages received at UPV OrionCB / Total number of expected messages in the evaluation period) × 100. Expected messages per sensor = evaluation period / configured reporting interval (currently 1 minute). A message is counted as received if it arrives within 2× the configured reporting interval of its expected time. Computed per sensor		UPV Orion Context Broker (Access NGSI-LD entities — totalCounterIn/totalCounterOut observation timestamps); Telefónica Smart City platform (data visualisation and device status).	Automated comparison of consecutive observation timestamps per Access entity in the UPV OrionCB against the configured reporting cadence; messages arriving later than 2× the configured interval, or missing entirely, are counted as non-compliant. Results aggregated per sensor and for the full deployment, cross-checked through the Telefónica Smart City platform.		At each evaluation stage

and aggregated across the 10 deployed sensors			
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
1. Unstable power supply on shared electrical circuits causing sensor downtime and missed reporting intervals; (2) weak radio signal at certain sensor locations degrading message delivery.		Electrical installation improvements with dedicated power connections for affected sensors (planned Phase 2); installation of a new antenna for signal reinforcement (planned Phase 2).	

Table 3-114: KPI-VSS-CL2-14 – Traffic-jam Detection False Positive Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	20%			5%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(false positive traffic-jams reported) / (total traffic jam reports)		Traffic Radars	Every time radars report a traffic-jam event, the AI based verification tool is deployed and in the process calibration stage, video will be saved for human verification purposes		At each evaluation stage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Incorrect traffic state threshold definition			Fine tuning traffic state thresholds		

3.2.2.3 Converted Business Value for Cluster 2

Table 3-115: KVI-VSS-CL2-1: User Satisfaction.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0,00%	50%			80%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
Percentage of users rating the COP-PILOT solution positively. Formula: (Number of responses scoring 4 or 5 / Total responses) * 100.	Direct end-user and operator satisfaction surveys, specifically comparing the "Before" (legacy processes) vs "After" (COP-PILOT platform) scenarios.	Distribution of numerical evaluation forms (1 to 5 scale) to the operational staff testing the pilot.		At each evaluation phase.	
Risk Management					
Identified Risk(s)		**Risk Mitigation Plan**			
Risk 1: Short exposure time bias. During the initial evaluation (M17), users haven't had enough time to deeply test the solutions in their daily routines. This leads to premature evaluations where users might initially perceive the tool as not useful due to the learning curve, or vice versa. Risk 2: Natural resistance to workflow changes, keeping the perceived satisfaction artificially stagnant despite technical improvements.		Allow for a natural adoption curve. Conduct follow-up surveys once the system is fully integrated into their long-term habits. Additionally, schedule hands-on training sessions to highlight the platform's utility.			

Table 3-116: KVI-VSS-CL2-2: Validation Performance.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0,00%	75,00%			100,00%	NOT ACHIEVED

KVI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(Number of installed devices operating correctly without hardware or network faults / Total number of installed devices) * 100.	Physical deployment inventory and automated hardware health-check diagnostics (heartbeats) from the platform dashboard.	Cross-referencing the official physical installation list against the real-time active telemetry logs to identify unresponsive, physically damaged, or malfunctioning nodes.	At each evaluation phase.

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Hardware malfunction due to harsh environmental conditions affecting the physical integrity of outdoor sensors.	Use industrial enclosures for all outdoor hardware.

Table 3-117: KVI-VSS-CL2-3: Market readiness.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	50	5		100%	NOT ACHIEVED

KVI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**

Number of VSA KPIs with an 'Achieved' status / Total number of evaluated KPIs * 100.	KPI tracking matrix and individual technical evaluation reports	Systematic audit of all individual VSA KPIs at the end of the evaluation cycle. The final status of each KPI is verified, and the successful metrics are aggregated to compute the overall operational success index.	At each evaluation phase.
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Unforeseen integration bottlenecks preventing the prototype from operating reliably in the real-world environment (stalling the project at TRL 5 or 6)		Conducting iterative, phased pilot testing to resolve integration issues early	

3.2.3 Evaluation of the Smart Agriculture Sector (Cluster 3A)

3.2.3.1 Evaluation of Common Platform Indicators

This section reports on the evaluation of common Platform KPIs as defined in Section 2.2, in the context of Cluster 3A. These KPIs are classified in 5 categories, i.e., Level of Fragmentation (KPI-VSA-FRA), Level of Security (KPI-VSA-SEC), Level of Automation (KPI-VSA-AUT), Piloting Infrastructure Scale (KPI-VSA-PIS), and Network Availability & Performance (KPI-VSA-NAP), which appear in order below.

3.2.3.1.1 KPI-VSA-FRA-APP-CL3A - Application Proliferation per Process

Table 3-118: KPI-VSA-FRA-APP-CL3A – Application Proliferation per Process.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
5	*2*			*2*	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (applications that comprise an end-to-end process)		*COP-PILOT platform application registry; AgroApps 360 integration logs; CL3A architecture documentation*	*AgroApps enumerates all applications comprising each end-to-end process (crop monitoring, traceability, logistics) at each assessment period, cross-referencing the platform registry*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.2 KPI-VSA-FRA-ICI-CL3A - Integration Complexity Index

Table 3-119: KPI-VSA-FRA-ICI-CL3A – Integration Complexity Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
40	*2,6*			*2,6*	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Σ (integration weight × count); 5 distinct nonintegrated apps	*COP-PILOT platform integration logs; AgroApps 360 API gateway configuration; iLink integration records*	*Collection Process: AgroApps enumerates all integration points across CL3A domains, assigns weights per integration type, and computes the index from platform and gateway logs*	*Once per assessment period*
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.3.1.3 KPI-VSA-FRA-DDR-CL3A - Data Duplication Rate

Table 3-120: KPI-VSA-FRA-DDR-CL3A – Data Duplication Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
4	*2*			*2*	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Σ (Number of systems storing the same data entity)/Total number of data entities	AgroApps 360 data model registry; FIWARE Orion-LD context broker entity catalogue; iLink blockchain data ledger	AgroApps audits which data entities (field observations, sensor readings, traceability records) are stored across multiple systems and computes the ratio against total distinct entities	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.3.1.4 KPI-VSA-FRA- DI^2-CL3A - Data Interoperability Index

Table 3-121: KPI-VSA-FRA- DI^2-CL3A – Data Interoperability Index.

KPI across project evaluation phases						
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**	
0	0.6			0.85	NOT ACHIEVED	
KPI Methodology						
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
DI^2 = Σ (data entities represented using a standardised data model) / Σ (total number of data entities)		FIWARE Orion-LD context broker entity catalogue; AgroApps 360 data model registry; iLink blockchain schema documentatio n	AgroApps audits all data entities across CL3A systems and identifies those exposed via NGSI-LD or other standardised models; ratio computed against total entity count		Once per assessment period	
Risk Management						
Identified Risk(s)			**Risk Mitigation Plan**			
Partial adoption of NGSI-LD across CL3A systems may slow DI2 improvement; legacy proprietary formats in some partner systems may resist standardisation			*FIWARE Orion-LD adopted as the common context broker; AgroApps leads data model harmonisation across partners. Non-NGSI-LD systems mapped via custom adapters.*			

3.2.3.1.5 KPI-VSA-FRA-ETC-CL3A - End-to-End Traceability Completeness

Table 3-122: KPI-VSA-FRA-ETC-CL3A – End-to-End Traceability Completeness.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
2/6	5/6	N/A	N/A	6/6	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
***ETC** formula: Fully traceable records / Total records*	*iLink Hyperledger Fabric blockchain transaction logs; AgroApps 360 crop calendar and harvest records; BAR facility intake records*	iLink queries blockchain ledger to count fully traceable supply chain records (field-to-gate) against total records generated per pilot season; BAR intake records used for cross-validation	*Once per assessment period*
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Incomplete data entry by farmers or BAR staff at field registration or harvest stages creates gaps in the traceability record.		*BAR agronomist support programme enforces data entry discipline. AgroApps 360 provides guided data entry workflows to minimise omissions.*	

3.2.3.1.6 KPI-VSA-FRA-TFI-CL3A - Total Fragmentation Index

Table 3-123: KPI-VSA-FRA-TFI-CL3A – Total Fragmentation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
84,6	*26,66*	*N/A*	*N/A*	*24,7*	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
APP = 0.3 / 0.85 = 0.3529 ICI = 0.3 / 0.85 = 0.3529 DDR = 0.15 / 0.85 = 0.1765 ETC = 0.1 / 0.85 = 0.1176	Computed from FRA-APP, FRA-ICI, FRA-DDR, FRA-DI2, and FRA-ETC tables above	AgroApps applies the TFI weighted formula using the values recorded in the five component KPI tables at each assessment period	*Once per assessment period*
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	

N/A	N/A

3.2.3.1.7 KPI-VSA-SEC-FED-CL3A - Federation Index

Table 3-124: KPI-VSA-SEC-FED-CL3A – Federation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.5			0.9	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
FED formula: Number of components using IAM / Total number of components		COP-PILOT platform IAM configuration records; orchestration layer component registry; AgroApps 360 Kubernetes service accounts	AgroApps audit all CL3A platform components and identify those registered under a centralised IAM; ratio computed against total component count		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.8 KPI-VSA-SEC-E2E-API-PROT-CL3A - End-to-end API protection Index

Table 3-125: KPI-VSA-SEC-E2E-API-PROT-CL3A – End-to-end API protection Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0.1	0.6			0.9	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

E2E-API-PROT formula: Σ (Number of application APIs protected by gateway or service mesh) / Total number of application APIs in end-to-end process	AgroApps 360 API gateway configuration; FIWARE Orion-LD endpoint registry; OpenZiti network overlay policy logs	AgroApps enumerates all API calls across CL3A end-to-end processes and identifies those routed through a gateway or service mesh; ratio computed per process and averaged	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.3.1.9 KPI-VSA-SEC-E2E-API-AUTH-CL3A - End-to-end API authentication Index

Table 3-126: KPI-VSA-SEC-E2E-API-AUTH-CL3A – End-to-end API authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0.1	0.7			0.9	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-API-AUTH formula: Σ (Number of application APIs with authentication or authorization) / Total number of application APIs in end-to-end process		AgroApps 360 API authentication logs; iLink blockchain API access records; FIWARE Orion-LD access control configuration	AgroApps audits all API calls across CL3A processes and identifies those requiring token, API-key, or OAuth authentication; ratio computed per process and averaged		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.10 KPI-VSA-SEC-E2E-EXT-AUTH-CL3A - End-to-end outbound Authentication Index

Table 3-127: KPI-VSA-SEC-E2E-EXT-AUTH-CL3A – End-to-end outbound Authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.6			0.9	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-EXT-AUTH formula: *Σ (Number of authenticated calls to external systems) / Total number of calls to external systems*		*OpenZiti tunnel policy logs; AgroApps 360 outbound API call records; iLink external integration logs*	*AgroApps and iLink audit all outbound calls to external systems and identify those authenticated via mTLS (OpenZiti) or OAuth; ratio computed across all CL3A external integrations*		*Once per assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.11 KPI-VSA-SEC-E2E-EV-LOG-CL3A - End-to-end Security event logging index

Table 3-128: KPI-VSA-SEC-E2E-EV-LOG-CL3A – End-to-end Security event logging index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.5			0.8	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-EV-LOG formula: Σ (Number of security events centrally logged/monitored) /		Source: Kubernetes cluster event logs (AgroApps	AgroApps aggregates security events from Kubernetes, OpenZiti, and blockchain audit logs; ratio of centrally captured events computed against total		Once per assessment period

Total number of security events	360, AUA AI nodes); Hyperledger Fabric audit trail; OpenZiti access event logs	events identified across all CL3A components	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.3.1.12 KPI-VSA-SEC-DATA-ENC-CL3A - Sensitive data encryption Index

Table 3-129: KPI-VSA-SEC-DATA-ENC-CL3A – Sensitive data encryption Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0.3	0.8			0.9	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DATA-ENC formula: Number of encrypted data operations / Total number of data operations		OpenZiti tunnel encryption logs; AgroApps 360 HTTPS traffic records; Hyperledger Fabric chain data encryption configuration; OTE 5G MPN link-layer encryption status	AgroApps audits all data operations (in transit and at rest) across CL3A systems and identifies those encrypted; ratio computed across all domains		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.13 KPI-VSA-SEC-TSI-CL3A - Total Security Index

Table 3-130: KPI-VSA-SEC-TSI-CL3A – Total Security Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
11	63			89	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TSI formula: 0.2 x FED + 0.2 x E2E-API-PROT + 0.2 x E2E-API-AUTH + 0.1 x E2E-EXT-AUTH + 0.1 x E2E-EV-LOG + 0.2 x DATA-ENC		Computed from the six-component security KPI tables above	AgroApps applies the TSI weighted formula using values recorded in the six component KPI tables at each assessment period		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.14 KPI-VSA-SEC-TSI-NIST-CL3A - Total Security Index by NIST

Table 3-131: KPI-VSA-SEC-TSI-NIST-CL3A – Total Security Index by NIST.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	3			5	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TSI-NIST formula		Computed from TSI table above	AgroApps maps the TSI score to the corresponding NIST Cybersecurity Framework maturity tier		Once per assessment period

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

3.2.3.1.15 KPI-VSA-AUT-TAI-CL3A – Total Automation Index

Depending on the scenario and field of business where automation needs to be quantified, one should define a set of stages where automation can be assessed individually. The following example shows how automation is quantified in a “AgriTech Transformation and Sustainability Initiative” value chain in the context of Cluster 3A. Table 3-132 defines the various stages of this value chain along with the typical set of tools used per stage.

Table 3-132: Automation stages for assessing Level of Automation in CL3A.

Stage Number	Stage Title	Typical tools used in stage
1	Crop planning & demand forecast	ERP, AI forecasting
2	Field operations (planting, irrigation)	IoT, Farm Mgmt. System
3	Crop monitoring	Sensors, drones, analytics
4	Harvest decision	Analytics, human
5	Harvest execution	Farm system
6	Post-harvest processing	Materials Management Software (MES) or Warehouse Management System (WMS)
7	Quality inspection	Vision AI, human
8	Traceability & certification	Blockchain / Trace system
9	Logistics	Transportation & logistics management
10	Retail delivery & confirmation	ERP, POS integration
11	Compliance reporting	Regulatory system

Next, Table 3-133 assigns an automation level from Table 2-14 to each automation stage.

Table 3-133: Automation levels per stages for assessing Level of Automation in CL3A.

Stage Title	Automation level as per 3GPP
Crop planning & demand forecast	3
Field operations (planting, irrigation)	4
Crop monitoring	4
Harvest decision	2
Harvest execution	3
Post-harvest processing	4
Quality inspection	1

Traceability & certification	3
Logistics	2
Retail delivery & confirmation	3
Compliance reporting	2

Moreover, Table 3-134 associates each automation stage with a weighted impact as not all stages exhibit the same importance in this specific value chain.

Table 3-134: Impact weight per stage for assessing Level of Automation in CL3A.

Stage Title	Impact Weight
Crop planning & demand forecast	2
Field operations (planting, irrigation)	5
Crop monitoring	3
Harvest decision	3
Harvest execution	2
Post-harvest processing	2
Quality inspection	5
Traceability & certification	4
Logistics	4
Retail delivery & confirmation	3
Compliance reporting	2

Based on the above information and the formula to measure “Total Automation Index” KPI, we derive the following values for this index in Table 3-135.

Table 3-135: KPI-VSA-AUT-TAI-CL3A – Total Automation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
25.1%	58.3%			64.6%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

TAI formula: Σ(weight × level) / Σ(weight × max level)	AgroApps 360 operational logs (crop planning, field operations, harvest records); AUA AI system activity logs; iLink blockchain and PowerFleet logistics records; BAR facility processing records	AgroApps assigns the current automation level per stage based on system logs and operational status at each assessment period, then applies the TAI formula across all 11 value chain stages	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.3.1.16 KPI-VSA-AUT-TAI-3GPP-CL3A – Total Automation Index by 3GPP

Having measured "Total Automation index" in Table 3-135, we use Table 2-19 to map this index to 3GPP automation levels, thus measure the equivalent KPI shown in Table 3-136.

Table 3-136: KPI-VSA-AUT-TAI-3GPP-CL3A – Total Automation Index by 3GPP.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	*3*			*3*	*ACHIEVED*
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TAI-3GPP formula		Computed from TAI table above	AgroApps maps the TAI percentage to the corresponding 3GPP automation level		*Once every assessment period*
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

3.2.3.1.17 KPI-VSA-PIS-COV-CL3A - Total covered area

Table 3-137: KPI-VSA-PIS-COV-CL3A – Total covered area.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>0
No IoT deployment before COP-PILOT</td><td>Operational IoT footprint across Central Macedonia (Kilkis pilot fields, Sindos facility, logistics corridors); quantification from AgroApps 360 field polygons and PowerFleet route logs pending</td><td></td><td></td><td>Fully cover 2 production farms plus 3 quantified logistics corridor footprints (km²)</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Σ (IoT domain area) = registered field plot polygons + facility footprint + logistics route corridors</td><td>AgroApps 360 field boundary polygons; PowerFleet GPS route logs and geofences; BAR Sindos facility footprint</td><td colspan="2">AgroApps sums registered plot polygon areas; iLink computes the logistics corridor area from PowerFleet route logs using a fixed corridor width; values aggregated per evaluation phase</td><td>At each evaluation phase</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">Corridor area depends on the width convention applied to route logs; changing it between phases would distort the trend</td><td colspan="3">Corridor width fixed and documented at first quantification and reused at every subsequent evaluation</td></tr>
</table>

3.2.3.1.18 KPI-VSA-PIS-REG-CNT-CL3A - Geographic dispersion

Table 3-138: KPI-VSA-PIS-REG-CNT-CL3A – Geographic dispersion.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
3	3			3	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
REG-CNT formula: Number of distinct geographic regions in your cluster		CL3A cluster architecture documentation; partner deployment records (AgroApps, BAR, iLink, OTE)	AgroApps counts distinct geographic regions with active CL3A infrastructure deployments: Kilkis (farm testbed), Sindos/Thessaloniki (BAR facility and AgroApps platform), and Athens (AUA, iLink, OTE core)		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Geographic region count is fixed at 3 for the duration of the project; no risk of change unless a partner relocates infrastructure			*No mitigation required.*		

3.2.3.1.19 KPI-VSA-PIS-DOM-CNT-CL3A - Domain count

Table 3-139: KPI-VSA-PIS-DOM-CNT-CL3A – Domain count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
>7	>7			>7	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
REG-CNT formula: Number of distinct		CL3A cluster architecture	AgroApps counts distinct administrative domains		Once per assessment period

geographic regions in your cluster	documentation; cop-pilot platform domain registry	registered in the COP-PILOT platform across CL3A, based on the cluster architecture	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Domain count may increase if new partner infrastructure is added through Open Calls		*Domain additions documented and flagged at each assessment period*	

3.2.3.1.20 KPI-VSA-PIS-DEV-CNT-CL3A - Device count

Table 3-140: KPI-VSA-PIS-DEV-CNT-CL3A – Device count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	100	N/A	N/A	122	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DEV-CNT formula: Σ (device count × weight)		AgroApps 360 device registry; OTE 5G MPN infrastructure inventory; AUA and TOR hardware deployment records; iLink and BAR infrastructure records	AgroApps compiles the full CL3A device inventory from partner records, assigns weights per device type, and computes the weighted sum at each assessment period		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Missing or unregistered devices could undercount the weighted total.			*AgroApps maintains a centralised device registry updated at each pilot phase. Partners required to report all new deployments within 30 days of installation*		

3.2.3.1.21 KPI-VSA-PIS-APP-CNT-CL3A - Application count

Table 3-141: KPI-VSA-PIS-APP-CNT-CL3A – Application count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	8	N/A	N/A	8	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
APP-CNT formula: Number of applications		COP-PILOT platform application registry; AgroApps 360 service catalogue; orchestration layer deployment records	AgroApps enumerates all deployed applications across CL3A domains from the platform registry and partner deployment records		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Application count may vary *if new partner applications areas added through Open Calls*			*Application additions documented and flagged at each assessment period*		

3.2.3.1.22 KPI-VSA-PIS-PROTO-CNT-CL3A - IoT Protocol diversity

Table 3-142: KPI-VSA-PIS-PROTO-CNT-CL3A – IoT Protocol diversity.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	7	N/A	N/A	7	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

PROTO-CNT formula: Number of communication protocols in use	AgroApps 360 integration layer protocol logs; OTE 5G MPN configuration; iLink and TOR communication stack documentation	AgroApps enumerates all communication protocols actively used across CL3A field and platform domains: MQTT, HTTPS/REST, 5G-NR, NGSI-LD, Hyperledger Fabric gRPC, OpenZiti overlay (mTLS).	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.3.1.23 KPI-VSA-PIS-TIS-CL3A - Total Infrastructure Scale Index

Table 3-143: KPI-VSA-PIS-TIS-CL3A – Total Infrastructure Scale Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5.07			5.16	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TIS formula: log10(COV x REG-CNT x DOM-CNT x DEV-CNT x APP-CNT x PROTO-CNT		Computed from the six component PIS KPI tables above	AgroApps applies the TIS formula using values recorded in the component PIS KPI tables at each assessment period		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.3.1.24 KPI-VSA-NAP-AV-CL3A - Network Availability

Table 3-144: KPI-VSA-NAP-AV-CL3A – Network Availability.

KPI across project evaluation phases

Baseline Value (M1)	Measured Value – Initial Evaluation (M17)	Measured Value – Intermediate Evaluation (M25)	Measured Value – Final Evaluation (M33)	Target Value (M36)	Assessment Result
N/A (No network infrastructure deployed on field)	N/A (No network infrastructure deployed on field)	Expected: 99%	Expected: 99%	Expected: 99%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Network Availability (%) = ((Total Operational Time − Downtime) / Total Operational Time) × 100		Network performance monitoring system, network management system, device status reports	Automatic collection of network uptime and downtime events through the monitoring infrastructure. Data are aggregated and validated periodically before KPI reporting		Monthly (with reporting at M17, M25 and M33)
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Delays in network infrastructure deployment, hardware failures, power outages, connectivity disruptions, environmental conditions affecting network operation			Detailed deployment planning and monitoring, preventive maintenance procedures, use of redundant components where feasible, continuous monitoring and rapid incident response procedures		

3.2.3.1.25 KPI-VSA-NAP-LAT-CL3A - Network Latency

Table 3-145: KPI-VSA-NAP-LAT-CL3A – Network Latency.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (No network infrastructure deployed on	N/A (No network infrastructure deployed	Expected: ≤ 20 ms	Expected: ≤ 20 ms	≤ 20 ms	NOT ACHIEVED

field yet)	on field yet)				
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Latency (ms) = Packet Arrival Timestamp – Packet Transmission Timestamp		Network monitoring tools, latency probes	Latency measurements are automatically collected through periodic network performance tests between defined endpoints. Results are aggregated and validated before KPI reporting		Monthly, with formal evaluations at M17, M25 and M33
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Network congestion, insufficient backhaul capacity, environmental interference, configuration errors			Network capacity planning, continuous performance monitoring, optimization of routing and traffic management, regular performance testing and corrective actions		

3.2.3.1.26 KPI-VSA-NAP-RATE-CL3A – Network Delivery Rate

Table 3-146: KPI-VSA-NAP-RATE-CL3A – Network Delivery Rate.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>N/A (5G network was not deployed in the field during the reporting period)</td><td>N/A (5G network was not deployed in the field during the reporting period)</td><td>Expected: ≥ 99%</td><td>Expected: ≥ 99%</td><td>≥ 99%</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Network Delivery Rate (%) = (Successfully Delivered Packets / Total Sent Packets) × 100</td><td>Network monitoring systems, traffic logs, application-level delivery reports</td><td colspan="2">The number of successfully delivered packets is compared against the total number of transmitted packets over defined communication links.</td><td>Monthly, with formal evaluations at M17, M25 and M33</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">Packet drops due to congestion, wireless interference, hardware/software failures</td><td colspan="3">Implementation of QoS mechanisms, continuous monitoring</td></tr>
</table>

3.2.3.1.27 KPI-VSA-NAP-PLR-CL3A - Packet Loss Rate

Table 3-147: KPI-VSA-NAP-PLR-CL3A – Packet Loss Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (No network infrastructure deployed on field yet)	N/A (No network infrastructure deployed on field yet)	Expected: 1%	Expected: 1%	≤ 1%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Packet Loss Rate (%) = (Lost Packets / Total Transmitted Packets) × 100		Network monitoring tools, traffic analysis logs	Packets transmitted between defined endpoints are counted and compared against successfully received packets. Loss events are recorded automatically by monitoring systems and aggregated for KPI reporting		Monthly, with formal evaluations at M17, M25 and M33
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Network congestion, wireless interference, environmental factors affecting transmission			QoS mechanisms, network monitoring and alerting		

3.2.3.1.28 KPI-VSA-NAP-JIT-CL3A - Network Delivery Rate

Table 3-148: KPI-VSA-NAP-JIT-CL3A – Network Jitter.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (No network infrastructure	N/A (No network infrastructure	Expected: ≤ 8 ms	Expected: ≤ 8 ms	≤ 8 ms	NOT ACHIEVED

deployed on field yet)	deployed on field yet)				
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Jitter (ms) = |Latency(i) − Latency(i−1)|		Network performance monitoring tools, packet timing logs	Continuous or periodic transmission of test packets between endpoints		Monthly, with formal evaluations at M17, M25 and M33
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Network congestion, variable traffic load, wireless interference, backhaul bottlenecks			QoS mechanisms, network slicing with prioritization of critical traffic, congestion monitoring		

3.2.3.1.29 KPI-VSA-NAP-REL-CL3A - Network Delivery Rate

Table 3-149: KPI-VSA-NAP-REL-CL3A – Network Reliability.

KPI across project evaluation phases						
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**	
N/A (No network infrastructure deployed on field yet)	N/A (No network infrastructure deployed on field yet)	Expected: 99%	Expected: 99%	99%	NOT ACHIEVED	
KPI Methodology						
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
Network Reliability (%) = (Number of Successful Network Operations / Total Number of Network Operations) × 100		Network monitoring platform, service logs, device logs	Reliability data are collected automatically through network monitoring and logging mechanisms. Successful and failed network operations are recorded, aggregated and analysed periodically		Monthly, with reports at M17, M25 and M33	
Risk Management						

Identified Risk(s)	Risk Mitigation Plan
Hardware failures, software faults, communication link degradation, configuration errors, environmental conditions affecting network operation	Preventive maintenance, continuous network monitoring, fault detection and recovery procedures, periodic system testing and configuration validation

3.2.3.1.30 KPI-VSA-NAP-RSRP-CL3A - Reference Signal Received Power

Table 3-150: KPI-VSA-NAP-RSRP-CL3A – Reference Signal Received Power.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (5G network was not deployed in the field during the reporting period)	N/A (5G network was not deployed in the field during the reporting period)	Expected: ≥ -90 dBm	Expected: ≥ -90 dBm	≥ -90 dBm	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
RSRP (dBm) = Average power level of the received reference signals		UE measurement reports, RAN performance counters	RSRP measurements are collected from user equipment and network monitoring systems during test sessions and field measurements. Values are aggregated and analysed for KPI reporting		M25 and M33
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Signal degradation due to distance, physical obstructions, environmental interference, suboptimal antenna configuration, weather conditions			Optimization of antenna placement, periodic coverage assessments, interference analysis		

3.2.3.1.31 KPI-VSA-NAP-RSRQ-CL3A – Reference Signal Received Quality

Table 3-151: KPI-VSA-NAP-RSRQ-CL3A – Reference Signal Received Quality.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (5G network was not deployed in the field during the reporting period)	N/A (5G network was not deployed in the field during the reporting period)	Expected: ≥ -12 dB	Expected: ≥ -12 dB	≥ -12 dB	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
RSRQ (dB) = Quality level of the received reference signal, derived from RSRP measurements		UE measurement reports, RAN performance counters, field measurements	RSRQ measurements are collected through user equipment reports and network monitoring systems during field testing and operational sessions. Values are aggregated and analysed for KPI reporting.		M25 and M33
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Interference from neighbouring cells, network congestion, environmental noise			Radio optimisation, interference management, antenna tuning, periodic network quality assessments		

3.2.3.1.32 KPI-VSA-NAP-SINR-CL3A – Signal-to-Interference-plus-Noise Ratio

Table 3-152: KPI-VSA-NAP-SINR-CL3A – Signal-to-Interference-plus-Noise Ratio.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A (5G network was not deployed in the field during the reporting period)	N/A (5G network was not deployed in the field during the reporting period)	Expected: ≥ 20 dB	Expected: ≥ 20 dB	≥ 20 dB	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
SINR (dB) = Signal Power / (Interference Power + Noise Power)		UE measurement reports, RAN performance counters, field measurements	SINR measurements are collected through user equipment reports and network monitoring systems during field testing		M25 and M33
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
High interference from neighbouring cells, environmental noise			Radio optimization, interference mitigation		

3.2.3.2 *Evaluation of Cluster 3A-specific Business Indicators*

Table 3-153: KPI-VSS-CL3A-1 - Farming Resource Optimization.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Conventional farming	Initial system deployment validated. Quantitative yield and resource comparison pending full growing season completion.			Yield +8%; Pesticide −20%; Water −15%; Fertiliser −10% VS. Baseline.	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Δ Yield = (Yield_pilot – Yield_baseline) / Yield_baseline × 100. & Per resource type: Δ Input = (Input_baseline – Input_pilot) / Input_baseline × 100.		AgroApps 360 Crop Calendar (inputs logged per field operation); BAR Agronomists Farm records; IoT weather station data.	BAR Agronomists and Farmers record all input applications (pesticide, water, fertiliser volumes per ha) in AgroApps 360 Crop Calendar. Yield is recorded once at harvest.		Throughout the growing season and harvest.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Extreme weather events distorting yield and input figures independently of COP-PILOT.			Comparing COP-PILOT plots vs. control plots where feasible; or even with past records for the same plots (where feasible and applicable).		
Farmer hesitation on changing cultivation activities to reflect platform recommendations			BAR agronomists support programme and farmer training (KPI-SOC-CL3A-2) will secure /drive COP-PILOT solutions adoption.		

Table 3-154: KPI-VSS-CL3A-2 - Agri-Ecosystem Integration & Security.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No domains were integrated before COP-PILOT. All systems operate independently.	80% of fixed domains & 100% of moving domains COP-PILOT platform integration initiated across 4 of 5 target domains. AgroApps 360, FIWARE Orion-LD, OTE 5G, and AUA AI nodes operational and interconnected. Hyperledger Fabric and PowerFleet integration progressing;			All 5+2 domains integrated and full interoperability achieved.	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Integration Index = (Integrated domains / Target domains) × 100.	COP-PILOT platform integration logs;	Integration is verified by functional testing.	Cntinuous monitoring, reported at each milestone/Pilot phase.

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

Table 3-155: KPI-VSS-CL3A-3 - Smart Logistics & Supply Chain Sustainability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A Static route planning, no real-time telemetry, no blockchain traceability.	N/A PowerFleet dispatch and routing deployed and active for the BAR-owned harvest fleet (same-day, open-truck inbound, no edge telemetry). Route and delivery data collection initiated during the Pilot 1 season. Blockchain traceability logging active for pilot delivery cycles; refrigerated-truck temperature telemetry (Raspberry Pi 5) scheduled for the Phase 2 outbound segment. Quantitative cost, spoilage, and CO_2 comparison pending full season aggregation.			Logistics planning cost −10%; Transit spoilage −15%; CO_2 per delivery −10%; 100% of deliveries fully traced.	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Logistics cost Δ = (Cost_baseline – Cost_pilot) / Cost_baseline × 100. Spoilage Δ =		iLink PowerFleet dispatch logs	iLink extracts route, delivery time, and fuel data from PowerFleet per delivery cycle. BAR records		Per delivery batch during pilot growing

(Spoilage_baseline − Spoilage_pilot) / Spoilage_baseline × 100. CO_2 Δ = (CO_2_baseline − CO_2_pilot) / CO_2_baseline × 100. Traceability coverage = Fully traced deliveries / Total deliveries × 100.	(route, transit time, fuel consumption per delivery); refrigerated-truck temperature telemetry from Raspberry Pi 5 edge nodes (Phase 2 outbound segment); BAR facility quality records (spoilage at intake gate); blockchain transaction logs.	spoilage at facility intake. Blockchain logs are queried for traceability coverage.	season; aggregated per evaluation/Pilot phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Outsourced transport vehicles not equipped with iLink telemetry, limiting traceability coverage.	Prioritise BAR-owned fleet for pilot traceability.
Seasonal variability in delivery volumes making cost/CO_2 comparisons unreliable.	Use the same deliveries for comparison; evaluate per Kg of transported goods.

Table 3-156: KPI-VSS-CL3A-3 - AI-Driven Crop Management.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A Calendar-based, manual scouting. No predictive models. Pest/disease detection	N/A AgroApps 360 AI alert system operational across pilot plots. UAV-based crop monitoring			Full predictive system operational across both plots. Accuracy, latency, and scouting reduction targets measurable.	NOT ACHIEVED

reactive and delayed.	flights conducted during Pilot 1 season. BAR agronomist scouting records collected as ground truth. System accuracy assessment initiated; statistically significant validation pending completion of full growing season event log.			Pest/disease detection accuracy ≥70%; Agronomist scouting visits reduction −40%	

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Accuracy = TP / (TP + FP + FN) × 100 (validated against ground-truth scouting). Scouting Reduction = (Visits_baseline − Visits_pilot) / Visits_baseline × 100.	AgroApps 360 alert logs; BAR agronomist scouting records (ground truth); IoT sensor and UAV data timestamps.	AgroApps 360 logs all generated alerts with timestamps. BAR agronomists record all physical scouting visits and findings. Ground-truth events used to validate model predictions retroactively.	Per growing season; reported at each evaluation/Pilot Phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Low pest/disease event incidence during pilot season, making accuracy statistically difficult to validate.	Design accuracy assessment to include additional test scenarios if natural event frequency is insufficient.

Table 3-157: KPI-VSS-CL3A-4 - UAV–UGV Autonomous Weed Management Efficiency.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Conventional uniform herbicide spraying across full field area. No UAV weed mapping. No UGV deployment.	N/A UAV weed mapping missions conducted across pilot plots during Pilot 1 season. AUA UGV deployed in human-in-the-loop mode for initial field validation. Mission logs and herbicide application records collected.			Full UAV–UGV cycle operational. All efficiency and reduction targets measurable across a complete growing season. UAV/UGV missions producing actionable weed maps ≥80%; UGV interventions successfully completed ≥85%; Herbicide volume reduction ≥25%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
UAV/UGV Success Rate = Actionable weed maps / Total UAV/UGV missions × 100 UGV Success Rate = Successfully completed interventions / Total triggered UGV missions × 100. Herbicide Reduction = (Volume_baseline – Volume_pilot) / Volume_baseline × 100.		AgroApps 360 logs all UAV/UGV missions and outputs. AUA logs all UGV activations and completions. BAR records herbicide volumes applied per hectare per intervention.	UAV and UGV logs cross-referenced per mission. Herbicide volumes compared against same-plot pre-COP-PILOT season baseline.		Per UAV/UGV mission during pilot growing season; aggregated per evaluation/ growing season/ Pilot phase.
Risk Management					

Identified Risk(s)	Risk Mitigation Plan
Regulatory constraints on autonomous UGV operation in open agricultural fields.	Human-in-the-loop validation is mandatory throughout all pilots' phases;

3.2.3.3 Converted Business Value for Cluster 3A

Table 3-158: KVI-VSS-CL3A-1: Agricultural Input Cost Savings for Contract Farmers.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No precision input management. Input quantities (pesticide, fertiliser, water) applied at uniform rates per BAR agronomist calendar recommendations, with no data-driven optimisation. Estimated average input cost: Weed control (labor + inputs): €200-400/ha Fertilizers: €700-900/ha Pesticides: €250-350/ha Irrigation: €350-500/ha Total: €2.800-3.300/ha	N/A AgroApps 360 precision recommendations active across pilot plots. Input logging initiated during Pilot 1 season. Cost saving quantification pending full season data aggregation and comparison against baseline records.			≥10% reduction in per-hectare input costs for contract farmers; ≥20% reduction in pesticide use; ≥15% reduction in water use; measurable reduction in agronomist field visit costs	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Cost saving (€/ha) = (Input_baseline − Input_pilot) × unit_cost per input type. Visit cost saving = (Visits_baseline − Visits_pilot) × average_visit_cost.	AgroApps 360 Crop Calendar (input quantities per field operation per plot); BAR agronomist records (baseline input rates and visit frequency); BAR contract farmer cost records.	AgroApps extracts input quantities per plot from the Crop Calendar at season end. BAR provides historical baseline input rates for the same plots. Cost saving computed by multiplying input reductions by current market unit prices.	Per growing season; reported at each evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Input cost savings depend on farmer adoption of platform recommendations and weather conditions; partial adoption reduces measurable savings. Market price volatility for inputs affects monetary comparison.	BAR agronomist support programme drives adoption. Savings reported both in physical units (kg/ha, m^3/ha) and monetary value to isolate price effects; continues benchmarking of what if scenarios.

Table 3-159: KVI-VSS-CL3A-2: Trusted & Traceable AgriFood Supply Chain.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A BAR operated manual traceability records covering farm-to-facility steps. No digital end-to-end data trail. No blockchain-recorded events.	N/A Hyperledger Fabric blockchain operational for pilot delivery cycles. End-to-end digital records initiated from field registration through to BAR facility intake. Blockchain event logging active.			100% of pilot deliveries covered by end-to-end blockchain data trail; ≥10 blockchain-recorded events per delivery cycle; full audit readiness demonstrated; consumer-facing provenance interface operational.	NOT ACHIEVED

Consumer-facing provenance visibility absent					

KVI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Traceability coverage (%) = Deliveries with complete blockchain trail / Total deliveries × 100. Blockchain event density = Total recorded events / Total delivery cycles	iLink Hyperledger Fabric blockchain transaction logs; AgroApps 360 farm registration and crop calendar records; BAR facility intake records.	iLink queries blockchain ledger for event count and coverage per delivery cycle. AgroApps cross-references farm-side records. BAR validates intake data completeness. Audit readiness assessed against predefined traceability checklist	Per delivery batch during pilot season; aggregated per evaluation phase.

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Incomplete data entry by farmers or BAR staff creates gaps in the blockchain trail. Outsourced transport legs not covered by iLink telemetry reduce end-to-end completeness.	BAR agronomist training programme ensures data entry compliance. Pilot traceability prioritises BAR-owned fleet and directly contracted farm plots

Table 3-160: KVI-VSS-CL3A-3: Supply Chain Efficiency & Product Freshness.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A Static route planning with no real-time telematics. Spoilage rate and transit time	N/A PowerFleet dispatch and routing active for the BAR harvest fleet (same-day, open-truck inbound, no edge			Transit spoilage reduction ≥15%; logistics planning cost reduction ≥10%;	NOT ACHIEVED

recorded manually at BAR facility intake. No logistics cost tracking per delivery cycle. Baseline spoilage rate: Estimated transport cost (field to BAR facility~40 min distance): €40–€60 per delivery trip, corresponding to approximately €15–€30 per ton or €200–€500/ha per cycle. Baseline spoilage rate is estimated at ~8–15% at intake, due to lack of real-time route optimization, absence of cold chain monitoring, and manual handling.	telemetry). Route, transit time, and fuel data collected per delivery cycle during the Pilot 1 season. Spoilage recorded at BAR intake gate. Quantitative comparison against baseline pending full season aggregation.			CO_2 per delivery reduction ≥10%; all pilot deliveries meeting freshness threshold at BAR facility gate.	
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Spoilage Δ (%) = (Spoilage_baseline − Spoilage_pilot) / Spoilage_baseline × 100. Freshness compliance (%) = Deliveries within freshness threshold / Total deliveries × 100. CO_2 Δ (%) = (CO_2_baseline − CO_2_pilot) / CO_2_baseline × 10		iLink PowerFleet telematics (route, transit time, fuel consumption per delivery); BAR facility quality and	Link extracts delivery performance data from PowerFleet per cycle. BAR records spoilage and freshness status at intake. Logistics cost extracted from BAR dispatch records. All metrics aggregated per pilot season and compared		Per delivery batch; aggregated per pilot season and evaluation phase

	spoilage records at intake gate; BAR logistics cost records.	against pre-COP-PILOT baseline.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Seasonal variability in harvest volumes and weather conditions affecting transit times independently of platform optimisation. Outsourced vehicles without telematics creating data gaps		Normalise metrics per kg of transported product to control for volume variability. Prioritise BAR-owned fleet for pilot measurement cycles.	

Table 3-161: KVI-VSS-CL3A-4: Shift from Reactive to Predictive Crop Protection.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Crop protection decisions based on fixed calendar schedules and manual field scouting. No predictive models or AI-triggered alerts. Pest and disease events detected reactively after visual confirmation. Baseline scouting visit frequency: 10–18 visits per growing cycle	N/A AgroApps 360 AI alert system operational across pilot plots. UAV-based monitoring flights conducted during Pilot 1 season providing proactive field intelligence. BAR agronomist scouting visit records collected. Transition from reactive to predictive mode initiated; accuracy and visit reduction quantification pending full season event log			Pest and disease detection accuracy ≥70% (validated against ground-truth scouting); agronomist scouting visit reduction ≥40%; demonstrable reduction in missed treatment windows and crop losses attributable to delayed detection	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Predictive accuracy (%) = TP / (TP + FP + FN) × 100. Scouting reduction (%) = (Visits_baseline − Visits_pilot) / Visits_baseline × 100. Missed events = pest/disease events not anticipated by AI system per season.	AgroApps 360 AI alert logs with timestamps; BAR agronomist scouting records (ground truth); UAV flight logs and imagery outputs; IoT weather station data.	AgroApps 360 alert logs cross-referenced against BAR agronomist ground-truth scouting records at season end. TP, FP, FN classified per event. Scouting visits compared against same-season baseline. Missed events counted from agronomist records not preceded by an AI alert.	Per growing season; reported at each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Low natural pest and disease incidence during a pilot season makes statistical accuracy validation difficult. Farmer or agronomist reluctance to reduce scouting visits before trusting AI recommendations.		Augment natural event assessment with controlled test scenarios if incidence is insufficient. BAR agronomist training and gradual handover plan builds confidence in AI-triggered interventions.	

Table 3-162: KVI-VSS-CL3A-5: Environmental Impact Reduction in Leafy Vegetable Production.

KVI-VSS-CL3A-5: Environmental Impact Reduction in Leafy Vegetable Production					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Conventional uniform input application across full field area. No precision herbicide targeting. No route optimisation for delivery CO_2. Environmental footprint not formally tracked.	N/A Precision input recommendations active via AgroApps 360. UAV weed mapping and AUA UGV targeted spot-spraying initiated during Pilot 1, reducing blanket herbicide application on mapped plots. PowerFleet route optimisation			Pesticide use reduction ≥20%; water use reduction ≥15%; herbicide volume reduction ≥25% through UAV–UGV precision targeting; CO_2 per delivery reduction ≥10%; measurable reduction in	NOT ACHIEVED

Baseline pesticide, water, fertiliser, and herbicide rates: Fertilizers: ~120–180 kg/ha N, 40–60 kg/ha P_2O_5, 60–100 kg/ha K_2O per cycle Pesticides: ~2–5 kg or L/ha per cycle (depending on disease pressure and number of applications) Herbicides: ~1–3 L/ha per cycle (where applied, often supplemented by manual weeding) Irrigation: ~2,000–4,000 m^3/ha per cycle	active, contributing to CO_2 reduction per delivery. Full environmental footprint quantification pending complete season data.			chemical runoff contributing to Farm-to-Fork and EU Green Deal targets.	

KVI Methodology

Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Per input type: Δ Input (%) = (Input_baseline − Input_pilot) / Input_baseline × 100. CO_2 Δ (%) = (CO_2_baseline − CO_2_pilot) / CO_2_baseline × 100. Chemical runoff reduction estimated from pesticide and herbicide volume reductions and application method shift.	AgroApps 360 Crop Calendar (input volumes per ha per operation); AUA UGV mission logs (herbicide volume applied per intervention); iLink	AgroApps aggregates input volumes from Crop Calendar and UAV–UGV mission logs at season end. CO_2 estimated from PowerFleet fuel consumption data using standard emission factors. All figures compared against pre-COP-PILOT baseline rates for the same or similar plots.	Per growing season; reported at each evaluation phase.

	PowerFleet fuel and route data (CO_2 estimation); BAR farm records (historical input baselines).		

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Attributing environmental improvements solely to COP-PILOT interventions is difficult when weather, pest pressure, and market factors also influence input decisions. Chemical runoff estimation is indirect.	Compare COP-PILOT plots against control plots using the same seasonal conditions. Report input reductions in physical units to separate from monetary effects. Flag runoff estimates as indicative

3.2.4 Evaluation of the Smart Energy Management Sector (Cluster 3E)

3.2.4.1 Evaluation of Common Platform Indicators

This section reports on the evaluation of common Platform KPIs as defined in Section 2.2, in the context of Cluster 3E. These KPIs are classified in 5 categories, i.e., Level of Fragmentation (KPI-VSA-FRA), Level of Security (KPI-VSA-SEC), Level of Automation (KPI-VSA-AUT), Piloting Infrastructure Scale (KPI-VSA-PIS), and Network Availability & Performance (KPI-VSA-NAP), which appear in order below.

3.2.4.1.1 KPI-VSA-FRA-APP-CL3E - Application Proliferation per Process

Table 3-163: KPI-VSA-FRA-APP-CL3E – Application Proliferation per Process.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	3			3	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Σ (applications that comprise an end-to-end process) across all CL3E UCs; measured per UC and summed.	COP-PILOT platform application registry and CL3E documentation	Enumeration of deployed applications per UC domain	At each evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
UC#3E.2 APP count is deployment-dependent; delays in onboarding the second EV site may result in M25 value remaining at 22.	Monitor EV site onboarding schedule closely; if second site is delayed, adjust M33/M36 target accordingly

3.2.4.1.2 KPI-VSA-FRA-ICI-CL3E - Integration Complexity Index

Table 3-164: KPI-VSA-FRA-ICI-CL3E – Integration Complexity Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
18	6.8			8.6	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
ICI = Σ (integration weight × count) across all cross-domain integrations in CL3E	CL3E integration architecture documentation	Enumeration of all cross-domain integrations per UC	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
-		-	

3.2.4.1.3 KPI-VSA-FRA-DDR-CL3E - Data Duplication Rate

Table 3-165: KPI-VSA-FRA-DDR-CL3E – Data Duplication Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1.9			2.18	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DDR = Σ (number of systems storing the same data entity) / total number of distinct data entities across CL3E		Platform data registry; FIWARE Context Broker instance logs per domain; cloud storage inventory	Enumeration of systems storing each data entity		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Intentional data replication across edge, cloud, and aggregator increases DDR compared to baseline; this is expected and by design as it enables real-time analytics, model training, and grid flexibility estimation			Document intentional replication as an architectural decision in CL3E deployment records to contextualise DDR increase		

3.2.4.1.4 KPI-VSA-FRA- DI^2-CL3E - Data Interoperability Index

Table 3-166: KPI-VSA-FRA- DI^2-CL3E – Data Interoperability Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.91			0.91	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DI2 = Σ (data entities represented using a standardised data model) / Σ (total number of data entities)		FIWARE Context Broker data model configurations per UC domain; OpenADR interface specification	Review of data model specifications for each of the CL3E data entities at each evaluation phase		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
If demand response adoption in UC#3E.1 is not achieved via standardized APIs within the project timeline, control signals would not qualify as standardized.			Fallback to MQTT-based demand response, with MQTT messages mapped to NGSI-LD entities where possible to preserve standardisation score		

3.2.4.1.5 KPI-VSA-FRA-ETC-CL3E - End-to-End Traceability Completeness

Table 3-167: KPI-VSA-FRA-ETC-CL3E – End-to-End Traceability Completeness.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

ETC = Fully traceable records / Total records; a record is considered fully traceable if it carries a source-level timestamp and can be followed from its origin through FIWARE Context Broker to its final	FIWARE Context Broker logs per UC domain	Verification of timestamp presence and FIWARE context chain for each of the 11 CL3E data entities	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Network interruptions between edge and cloud nodes may create gaps in the audit trail for affected records		Implement local edge buffering to preserve record integrity during network interruptions	

3.2.4.1.6 KPI-VSA-FRA-TFI-CL3E - Total Fragmentation Index

Table 3-168: KPI-VSA-FRA-TFI-CL3E – Total Fragmentation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
55.0	55.8			60.7	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TFI = [0.3 × Norm(APP) + 0.3 × Norm(ICI) + 0.15 × Norm(DDR) + 0.15 × (1 − DI2) + 0.1 × (1 − ETC)] × 100		Computed from Tables KPI-VSA-FRA-APP-CL3E, KPI-VSA-FRA-ICI-CL3E, KPI-VSA-FRA-DDR-CL3E, KPI-VSA-FRA-DI2-CL3E, and KPI-VSA-FRA-ETC-CL3E	The five-constituent fragmentation KPIs are collected per their individual measurement processes; TFI is then computed by applying the weighted formula above		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
-			-		

3.2.4.1.7 KPI-VSA-SEC-FED-CL3E - Federation Index

Table 3-169: KPI-VSA-SEC-FED-CL3E – Federation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.39			0.6	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
FED = Number of components using centralised IAM (Keycloak) / Total number of components across all CL3E domains	Keycloak instance configuration records per UC & documentation		Enumeration of all CL3E components; classification of each component as Keycloak-protected or not based on deployment configuration		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Keycloak misconfiguration at a domain level could leave dashboards or databases unprotected			include Keycloak configuration verification in deployment checklist		

3.2.4.1.8 KPI-VSA-SEC-E2E-API-PROT-CL3E - End-to-end API protection Index

Table 3-170: KPI-VSA-SEC-E2E-API-PROT-CL3E – End-to-end API protection Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-API-PROT = Σ (number of application APIs protected by gateway or service mesh) / Total number of application APIs in end-to-end process	SIF configuration and connection logs & documentation		Verification of protection mechanism for each API interface across all CL3E domains; inter-domain connections verified against SIF whitelist configuration; intra-domain connections verified against HTTPS configuration per domain		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
HTTPS misconfiguration within a domain could leave intra-domain API calls unprotected			Include HTTPS and SIF configuration verification in deployment checklist for all new domain deployments		

3.2.4.1.9 KPI-VSA-SEC-E2E-API-AUTH-CL3E - End-to-end API authentication Index

Table 3-171: KPI-VSA-SEC-E2E-API-AUTH-CL3E – End-to-end API authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.62			0.62	ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
E2E-API-AUTH = Σ (number of application APIs with authentication or authorisation) / Total number of application APIs in end-to-end process	Keycloak configuration records; SIF identity policy configuration; documentation	Classification of each application interface as authenticated	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Intra-domain microservice calls rely solely on network isolation without application-level authentication, representing a residual risk if domain network boundaries are compromised		Document reliance on network isolation for intra-domain calls as an accepted architectural decision	

3.2.4.1.10 KPI-VSA-SEC-E2E-EXT-AUTH-CL3E – End-to-end outbound Authentication Index

Table 3-172: KPI-VSA-SEC-E2E-EXT-AUTH-CL3E – End-to-end outbound Authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-EXT-AUTH = Σ (number of authenticated calls to external/cross-domain systems) / Total number of calls to external/cross-domain systems	SIF connection logs and identity policy configuration		Enumeration of all cross-domain boundary connections; verification that each connection passes through SIF with valid certificate-based mutual authentication		At each evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
If CL3E integrates with truly external third-party systems in future open call phases, those connections may not immediately be covered by SIF, temporarily reducing E2E-EXT-AUTH	Enforce SIF integration as a mandatory requirement for any new external or cross-domain connection

3.2.4.1.11 KPI-VSA-SEC-E2E-EV-LOG-CL3E - End-to-end Security event logging index

Table 3-173: KPI-VSA-SEC-E2E-EV-LOG-CL3E – End-to-end Security event logging index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.2			0.2	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-EV-LOG = Σ (number of security events centrally logged and monitored) / Total number of security events	SIF centralised connection logs; per-domain Keycloak logs (for local logging verification)		Assessment of logging architecture		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.4.1.12 KPI-VSA-SEC-DATA-ENC-CL3E - Sensitive data encryption Index

Table 3-174: KPI-VSA-SEC-DATA-ENC-CL3E – Sensitive data encryption Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.63			0.63	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Number of encrypted data operations / Total number of data operations	SIF encryption configuration; HTTPS configuration per domain; sensor interface specifications		Classification of each data operation as encrypted or unencrypted		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Sensor-to-edge layer unencrypted in UC#3E.2 and UC#3E.3			Mitigate sensor-to-edge risk through physical security measures at deployment sites		

3.2.4.1.13 KPI-VSA-SEC-TSI-CL3E - Total Security Index

Table 3-175: KPI-VSA-SEC-TSI-CL3E – Total Security Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	64.6			69.0	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
TSI = (0.2 × FED + 0.2 × E2E-API-PROT + 0.2 × E2E-	Computed from Tables: KPI-VSA-SEC-FED-CL3E, KPI-VSA-SEC-E2E-API-PROT-CL3E, KPI-VSA-SEC-E2E-API-AUTH-CL3E, KPI-VSA-SEC-E2E-EXT-AUTH-CL3E, KPI-		The six-constituent security KPIs are collected per their individual measurement processes; TSI is then		At each evaluation phase

API-AUTH + 0.1 × E2E-EXT-AUTH + 0.1 × E2E-EV-LOG + 0.2 × DATA-ENC) × 100,	VSA-SEC-E2E-EV-LOG-CL3E, and KPI-VSA-SEC-DATA-ENC-CL3E	computed by applying the weighted formula above	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.4.1.14 KPI-VSA-SEC-TSI-NIST-CL3E - Total Security Index by NIST

Table 3-176: KPI-VSA-SEC-TSI-NIST-CL3E – Total Security Index by NIST.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	3			3	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
If KPI-VSA-SEC-TSI-CL3E in: 0–10 → Level 0 (Non-existent); 11–30 → Level 1 (Initial); 31–50 → Level 2 (Basic); 51–70 → Level 3 (Defined); 71–85 → Level 4 (Managed); 86–100 → Level 5	KPI-VSA-SEC-TSI-CL3E		KPI-VSA-SEC-TSI-CL3E table is checked to extract the KPI value		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.4.1.15 KPI-VSA-AUT-TAI-CL3E – Total Automation Index

Depending on the scenario and field of business where automation needs to be quantified, one should define a set of stages where automation can be assessed individually. The following example shows how automation is quantified in a "Edge Intelligence for Enhancing Grid Reliability in RES-Rich Distribution Grids" value chain in the context of Cluster 3E. Table 3-177 defines the various stages of this value chain along with the typical set of tools used per stage.

Table 3-177: Automation stages for assessing Level of Automation in CL3E.

Stage Number	Stage Title	Typical tools used in stage
1	Sensor Data Acquisition	Inductive sensors, Modbus TCP gateway (Ewon Flexy 205), DER simulators (RPi), MQTT
2	Data Ingestion & Contextualization	FIWARE Context Broker (NGSI-LD), MQTT broker, edge database (MongoDB and CrateDB)
3	Edge Analytics & AI Inference	Containerized ML microservices (Jetson Orin), anomaly detection, forecasting models
4	Flexibility Estimation	Flexibility estimation microservice (ADMS), IEC 61850, ETSI NGSI-LD
5	Decision & Control Signal Generation	DER control microservice, OpenADR
6	Model Retraining & Deployment	Cloud analytics platform, CI/CD pipeline, OSL & HiPO orchestration
7	Operator Oversight & Reporting	Dashboard, Keycloak

Next, Table 3-178 assigns an automation level from Table 2-14 to each automation stage.

Table 3-178: Automation levels per stages for assessing Level of Automation in CL3E.

Stage Title	Automation level as per 3GPP
Sensor Data Acquisition	5
Data Ingestion & Contextualization	5
Edge Analytics & AI Inference	5
Flexibility Estimation	5
Decision & Control Signal Generation	4
Model Retraining & Deployment	4
Operator Oversight & Reporting	3

Moreover, Table 3-179 associates each automation stage with a weighted impact as not all stages exhibit the same importance in this specific value chain.

Table 3-179: Impact weight per stage for assessing Level of Automation in CL3E.

Stage Title	Impact Weight
Sensor Data Acquisition	1
Data Ingestion & Contextualization	1
Edge Analytics & AI Inference	2

Flexibility Estimation	2
Decision & Control Signal Generation	2
Model Retraining & Deployment	1
Operator Oversight & Reporting	1

Based on the above information and the formula to measure "Total Automation Index" KPI, we derive the following values for this index in Table 3-180.

Table 3-180: KPI-VSA-AUT-TAI-CL3E – Total Automation Index.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><td>Baseline Value (M1)</td><td>Measured Value – Initial Evaluation (M17)</td><td>Measured Value – Intermediate Evaluation (M25)</td><td>Measured Value – Final Evaluation (M33)</td><td>Target Value (M36)</td><td>Assessment Result</td></tr>
<tr><td>4</td><td>56</td><td></td><td></td><td>90</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><td>Measurement Calculation Formula</td><td colspan="2">Measurement Input Source</td><td colspan="2">Measurement Collection Process</td><td>Measurement Collection Frequency</td></tr>
<tr><td>$TAI = [\Sigma(w_i \times l_i) / (5 \times \Sigma w_i)] \times 100$, where w_i is the impact weight of stage i and l_i is the 3GPP automation level (0–5) of stage i</td><td colspan="2">System deployment logs, operational records, and pilot evaluation reports</td><td colspan="2">Each operational stage is assessed against the 3GPP automation level scale (0–5). The weighted average is computed using the impact weights defined in Table 3134 and normalised to a 0–100 index.</td><td>At each evaluation phase</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><td colspan="3">Identified Risk(s)</td><td colspan="3">Risk Mitigation Plan</td></tr>
<tr><td colspan="3">Automation level of some stages may remain below target if human-in-the-loop configuration is retained as default in operational scenarios beyond the pilot phase.</td><td colspan="3">Configurable actuation mode (automatic vs. human-confirmed) is built into the architecture. Target level reflects the technically achievable maximum within the pilot scope. Demonstrated zero-touch capability is documented even if human confirmation remains the operational default.</td></tr>
</table>

3.2.4.1.16 KPI-VSA-AUT-TAI-3GPP-CL3E – Total Automation Index by 3GPP

Having measured "Total Automation index" in Table 3-180, we use Table 2-19 to map this index to 3GPP automation levels, thus measure the equivalent KPI shown in Table 3-181.

Table 3-181: KPI-VSA-AUT-TAI-3GPP-CL3E – Total Automation Index by 3GPP.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0.2	2.8			4.5	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
TAI-3GPP = $\Sigma(w_i \times l_i) / \Sigma w_i$, where w_i is the impact weight of stage i and l_i is the 3GPP automation level (0–5) of stage i. Result expressed on the 0–5 scale.	System deployment logs, operational records, and pilot evaluation reports		Stage assessments and weights defined in Table 3134		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.4.1.17 KPI-VSA-PIS-COV-CL3E - Total covered area

Table 3-182: KPI-VSA-PIS-COV-CL3E – Total covered area.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0.01 km^2	0.05 km^2			0.5 km^2	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Sum of IoT domain area in	Physical site survey of UoP lab, BPO biogas plant, and PPC EV charging sites		Manual measurement of IoT device deployment footprint per domain		At each evaluation phase

km² across all CL3E domains			
Risk Management			
Identified Risk(s)	**Risk Mitigation Plan**		
EV site access restrictions may delay deployment	Coordinate with PPC for earlier site access		

3.2.4.1.18 KPI-VSA-PIS-REG-CNT-CL3E - Geographic dispersion

Table 3-183: KPI-VSA-PIS-REG-CNT-CL3E – Geographic dispersion.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	2			2	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Count of distinct geographic regions hosting CL3E IoT domains	CL3E deployment site documentation		Enumeration of distinct geographic regions based on deployment site locations		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.4.1.19 KPI-VSA-PIS-DOM-CNT-CL3E - Domain count

Table 3-184: KPI-VSA-PIS-DOM-CNT-CL3E – Domain count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	4			6	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**

Count of distinct administrative domains managed by separate organisations across all CL3E UCs; each independently managed infrastructure node counts as one domain	Partner infrastructure inventories	Enumeration of administrative domains	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Domain integration delays due to heterogeneous partner infrastructure and varying partner readiness levels		Early alignment on domain definitions and integration protocols	

3.2.4.1.20 KPI-VSA-PIS-DEV-CNT-CL3E - Device count

Table 3-185: KPI-VSA-PIS-DEV-CNT-CL3E – Device count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	100			173	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (device count × weight): simple sensor=1, smart sensor=2, gateway=5, 5G cell=8, edge compute node=10, cloud compute node=15	Hardware inventory lists		Device enumeration and classification per domain at their deployment; weighted count calculated using the standard formula defined in Section 2.2.4		At each evaluation phase
Risk Management					

Identified Risk(s)	Risk Mitigation Plan
Device failures or procurement delays may reduce the device count.	Exploit already existing devices offered by UoP and PNET.

3.2.4.1.21 KPI-VSA-PIS-APP-CNT-CL3E - Application count

Table 3-186: KPI-VSA-PIS-APP-CNT-CL3E – Application count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	12			21	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
Count of distinct microservices deployed and operational	OpenSlice service catalogue and application documentation		Enumeration of deployed microservices, platform components, and applications per domain		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Some microservices may be merged or split during development iterations, affecting the count			Maintain a versioned application registry		

3.2.4.1.22 KPI-VSA-PIS-PROTO-CNT-CL3E - IoT Protocol diversity

Table 3-187: KPI-VSA-PIS-PROTO-CNT-CL3E – IoT Protocol diversity.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5			6	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**

Count of distinct IoT and data communication protocols actively used	CL3E architecture documentation	Interface specifications of each UC, validated against actual deployment configurations	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Integrated protocols may become outdated for specific domains		Adopt newly standardized protocols	

3.2.4.1.23 KPI-VSA-PIS-TIS-CL3E - Total Infrastructure Scale Index

Table 3-188: KPI-VSA-PIS-TIS-CL3E – Total Infrastructure Scale Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	3.38			5.12	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
TIS = $\log_{10}$(COV × REG-CNT × DOM-CNT × DEV-CNT × APP-CNT × PROTO-CNT)	Computed from: KPI-VSA-PIS-COV-CL3E, KPI-VSA-PIS-REG-CNT-CL3E, KPI-VSA-PIS-DOM-CNT-CL3E, KPI-VSA-PIS-DEV-CNT-CL3E, KPI-VSA-PIS-APP-CNT-CL3E, and KPI-VSA-PIS-PROTO-CNT-CL3E		The six sub-KPIs are collected per their individual measurement processes; TIS is then computed		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.4.2 Evaluation of Cluster 3E-specific Business Indicators

Table 3-189: KPI-VSS-CL3E-1 - RES Intermittency.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~4%			≥10%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
RES share increase (%) = (RES energy delivered post-deployment − RES energy delivered at baseline) / RES energy delivered at baseline × 100		Energy consumption and delivery records from UC#3E.1 grid simulator and connected DER assets	RES energy delivery logged per scenario		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Measurement relies on simulated grid scenarios rather than live grid data; results may not fully reflect real-world RES variability			Injection of real-world data from the Biogas plant, the EV chargers, and generation/consumption assets through the open calls, to make simulation more realistic		

Table 3-190: KPI-VSS-CL3E-2 - Grid Overload.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~1%			≥2%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Overload reduction (%) = (number of overload/over-voltage events at baseline − number of events post-deployment) /		Grid event logs from ADMS; DER control signal records	Grid events logged per scenario		At each evaluation phase

number of events at baseline × 100			
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Measurement relies on simulated grid scenarios rather than live grid data; results may not fully reflect real-world RES variability		Injection of real-world data from the Biogas plant, the EV chargers, and generation/consumption assets through the open calls, to make simulation more realistic	

Table 3-191: KPI-VSS-CL3E-3- Flexibility Activation Time.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
-	600ms			300ms	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Activation latency (ms) = timestamp of DER control signal issued − timestamp of congestion event detected by ADMS		ADMS event logs; flexibility estimation timestamps; DER control logs	Timestamped logs captured		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-192: KPI-VSS-CL3E-4 – Edge Decision-Making.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~5%			≥10%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Cost reduction of Decision Making (%) = (estimated cost of centralised decision-making at baseline − estimated cost of edge-based decision-making) / baseline cost × 100	Data transmission logs; edge processing records	Data transmission volumes and processing costs estimated at baseline and compared against edge-local processing metrics at each milestone	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Cost reduction is partially model-based and relies on assumptions about centralised processing costs		Cost model documented and validated with partners	

Table 3-193: KPI-VSS-CL3E-5 – Biogas Plant Profitability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~2%			≥5%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Profitability improvement (%) = (production hours recovered + maintenance cost savings) / baseline production and maintenance costs × 100		BPO production logs; maintenance cost records; downtime event records	Baseline production and maintenance costs established at M1 from BPO historical records; compared against post-deployment records at each milestone		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
BPO historical data quality may be insufficient to establish a reliable baseline; seasonal variation in biogas production may confound results			BPO data collection initiated from M7		

Table 3-194: KPI-VSS-CL3E-6 – Biogas Plant Unplanned Downtime.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~2%			>5%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Downtime reduction (%) = (unplanned downtime hours at baseline − post-deployment) / baseline × 100		BPO downtime logs; Analytics inference logs; anomaly detection model evaluation reports	Downtime events logged		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Insufficient baseline downtime data may limit statistical significance; model accuracy may degrade if process conditions change significantly			BPO data collection initiated from M7		

Table 3-195: KPI-VSS-CL3E-7 – Biogas By-Product Cost.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~0.5%			>5 %	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
By-product cost reduction (%) = (baseline by-product costs − post-deployment by-		BPO operational cost records; biogas production and dispatch	Baseline by-product costs established from BPO financial records; post-deployment costs compared at each milestone, cross-referenced with flexibility dispatch frequency and volume		At each evaluation phase

product costs) / baseline costs × 100	logs; flexibility dispatch records		
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
By-product cost data may be difficult to isolate from overall operational costs		Minimum flexibility dispatch scenarios documented even if full cost savings cannot be demonstrated within pilot timeframe	

Table 3-196: KPI-VSS-CL3E-8 – EV Charging Demand Forecasting Accuracy.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~70%			≥90%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Forecasting accuracy (%) = 1 – (actual values – forecasted ones) / actual values x 100		Edge analytics inference logs	Forecasting accuracy evaluated on held-out test set at each cycle		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Accuracy may be limited at early stages due to small dataset			Model retraining		

Table 3-197: KPI-VSS-CL3E-9 – EV Charger Uptime.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~8%			≥20%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Uptime increase reduction (%) = 1 - (baseline downtime –		Charger operational logs; edge	Baseline downtime from historical records; post-		At each evaluation phase

post-deployment downtime) / baseline × 100		analytics inference logs	deployment tracked via edge node logs		
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-198: KPI-VSS-CL3E-10 Flexibility Estimation Accuracy.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~75%			≥90%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Estimation accuracy (%) = 1 − MAE between estimated flexibility (kW) and actual DER response (kW), normalised by mean estimated flexibility		Flexibility estimation logs; DER control response records	For each scenario run, estimated flexibility compared against actual DER response; MAE computed and normalised		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-199: KPI-VSS-CL3E-11 Charger Fault Prediction Activity.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	15%			≥25%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Fault prediction activity (%) = (number of charging sessions with ≥1 fault prediction generated) / (total charging sessions) × 100	Edge analytics inference logs	Fault prediction events cross-referenced with charging session records	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Low fault rate during normal operation may result in a low percentage that does not reflect system capability		Test fault injection scenarios used for validation	

3.2.4.3 Converted Business Value for Cluster 3E

Table 3-200: KVI-VSS-CL3E-1: Edge-Based Flexibility Orchestration.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
10s	1,1s			700ms	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Activation latency (ms) = timestamp of DER control signal issued − timestamp of congestion event detected by ADMS.		ADMS event logs, flexibility estimation timestamps, DER control logs. DER control response records.	Timestamped logs captured.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-201: KVI-VSS-CL3E-2: Renewable Integration at Distribution Level.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~4%; ~1%			≥10%; ≥2%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
RES share increase (%) = (RES energy delivered post-deployment – RES energy delivered at baseline) / RES energy delivered at baseline × 100.		Energy consumption and delivery records from UC#3E.1 grid simulator and connected DER assets, DER control signal records.	RES energy delivery logged per scenario; grid events logged per scenario.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-202: KVI-VSS-CL3E-3: CO_2 Optimisation of Charging Energy.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	~70%			≥90%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Forecasting accuracy (%) = 1 – (actual values – forecasted values) / actual values × 100.					

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

Table 3-203: KVI-VSS-CL3E-4: Biogas Equipment Lifetime Extension.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	N/A			>5%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Uptime increase (%) = 1 – (baseline downtime – post-deployment downtime) / baseline × 100.		Biogas digester measurement logs, edge analytics inference logs.	Baseline downtime from historical records. post-deployment tracked via edge node logs.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Sensors deployed during the project so there are no initial / historical data			Baseline will be established by M20.		

Table 3-204: KVI-VSS-CL3E-5: Reduced Emergency Maintenance Visits.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	N/A			5%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Uptime increase (%) = 1 − (baseline downtime − post-deployment downtime) / baseline × 100.	Charger operational measurements; edge analytics inference logs.	Baseline downtime from historical records; post-deployment tracked via edge node logs.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
1. Sensors deployed during the project so there are no initial / historical data 2. Actual downtime may not occur during the project's lifetime		1. Baseline will be established by M23. 2. Simulated faults will trigger maintenance alarms.	

Table 3-205: KVI-VSS-CL3E-6: Local Energy Autonomy & EU Digital Sovereignty.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	N/A			5%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Reliability Increase (%) = (unplanned downtime hours at baseline − post-deployment) / baseline × 100. Sensitive industrial data never leave premises.		BPO production logs; maintenance records; downtime event records; analytics inference logs;	Baseline production and maintenance events captured from BPO historical records. Compared against post-deployment records.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Actual downtime may not occur during the project's lifetime			Simulated faults will trigger maintenance alarms.		

3.2.5 Evaluation of the Smart Vineyards Sector (Cluster 4)

3.2.5.1 Evaluation of Common Platform Indicators

This section reports on the evaluation of common Platform KPIs as defined in Section 2.2, in the context of Cluster 4. These KPIs are classified in 5 categories, i.e., Level of Fragmentation (KPI-VSA-FRA), Level of Security (KPI-VSA-SEC), Level of Automation (KPI-VSA-AUT), Piloting Infrastructure Scale (KPI-VSA-PIS), and Network Availability & Performance (KPI-VSA-NAP), which appear in order below.

3.2.5.1.1 KPI-VSA-FRA-APP-CL4 - Application Proliferation per Process

Table 3-206: KPI-VSA-FRA-APP-CL4 – Application Proliferation per Process.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><td>Baseline Value (M1)</td><td>Measured Value – Initial Evaluation (M17)</td><td>Measured Value – Intermediate Evaluation (M25)</td><td>Measured Value – Final Evaluation (M33)</td><td>Target Value (M36)</td><td>Assessment Result</td></tr>
<tr><td>0</td><td>7</td><td></td><td></td><td><=9</td><td>ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><td colspan="2">Measurement Calculation Formula</td><td>Measurement Input Source</td><td colspan="2">Measurement Collection Process</td><td>Measurement Collection Frequency</td></tr>
<tr><td colspan="2">Σ (applications that comprise an end-to-end process) across all CL4 UCs; measured per UC and summed.</td><td>COP-PILOT platform application registry; CL4 architecture documentation.

Nokia expects to add 2 more OpenSlice services in UC4.4</td><td colspan="2">Enumeration of deployed applications per UC domain</td><td>Once per assessment period</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><td colspan="3">Identified Risk(s)</td><td colspan="3">Risk Mitigation Plan</td></tr>
<tr><td colspan="3">A high number of standalone applications or data silos can fragment data and hinder interoperability, limiting end-to-end automation in the COP-PILOT platform.</td><td colspan="3">Reduce data silos by consolidating or federating isolated datasets</td></tr>
</table>

3.2.5.1.2 KPI-VSA-FRA-ICI-CL4 - Integration Complexity Index

Table 3-207: KPI-VSA-FRA-ICI-CL4 – Integration Complexity Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	11.2			<=14	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (integration weight × count)		COP-PILOT Cluster 4 platform integration diagrams **Nokia expects to add 2 more OpenSlice services in UC4.4**	Enumeration of all cross-domain integrations per UC		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.5.1.3 KPI-VSA-FRA-DDR-CL4 - Data Duplication Rate

Table 3-208: KPI-VSA-FRA-DDR-CL4 – Data Duplication Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	8			<=8	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DDR = Σ (number of systems storing the same data entity) /		Platform data registry; FIWARE	Enumeration of systems storing each data entity		At each evaluation phase

total number of distinct data entities across CL4	Context Broker instance logs per domain; cloud storage inventory		
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Intentional data replication across edge, cloud, and aggregator increases DDR compared to baseline; this may be expected and by design if it enables real-time analytics, model training, and grid flexibility estimation		Document intentional replication as an architectural decision in CL4 deployment records to contextualise DDR increase	

3.2.5.1.4 KPI-VSA-FRA- DI^2-CL4 - Data Interoperability Index

Table 3-209: KPI-VSA-FRA- DI^2-CL4 – Data Interoperability Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
DI2 = Σ (data entities represented using a standardised data model) / Σ (total number of data entities)		FIWARE Orion-LD context broker entity catalogue	Audition of all data entities across CL4 systems and identification those exposed via NGSI-LD; ratio computed against total entity count		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low level of compliance with standardized data models (e.g., NGSI-LD) may lead to reduced interoperability and fragmented data flows across the platform			Increase alignment with standardized data models by ensuring that data entities are structured using NGSI-LD or equivalent standards, improving interoperability and enabling consistent data exchange across systems.		

3.2.5.1.5 KPI-VSA-FRA-ETC-CL4 – End-to-End Traceability Completeness

Table 3-210: KPI-VSA-FRA-ETC-CL4 – End-to-End Traceability Completeness.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
ETC = Fully traceable records / Total records; a record is considered fully traceable if it carries a source-level timestamp and can be followed from its origin through FIWARE Context Broker to its final		FIWARE Context Broker logs per UC domain	Verification of timestamp presence and FIWARE context chain for each of the CL4 data entities		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Network interruptions between edge and cloud nodes may create gaps in the audit trail for affected records			(Nokia) Local edge buffering has been implemented to preserve record integrity during network interruptions		

3.2.5.1.6 KPI-VSA-FRA-TFI-CL4 – Total Fragmentation Index

Table 3-211: KPI-VSA-FRA-TFI-CL4 – Total Fragmentation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.62			0.60	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

TFI formula: 0.3 x Normalized (APP) + 0.3 x Normalized (ICI) + 0.15 x Normalized (DDR) + 0.15 x (1 - DI2) + 0.1 x (1 – ETC)	Computed from Tables KPI-VSA-FRA-APP-CL4, KPI-VSA-FRA-ICI-CL4, KPI-VSA-FRA-DDR-CL4, KPI-VSA-FRA-DI2-CL4, and KPI-VSA-FRA-ETC-CL4	The TFI is calculated using the weighted formula above, combining the five individual fragmentation KPIs collected through their respective methods.	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
A high TFI score indicates significant fragmentation across systems and data layers, which may lead to inconsistent data, limited interoperability, and reduced ability to perform reliable end-to-end operations and analysis.		Reduce fragmentation by consolidating systems, standardizing data models, and improving traceability to progressively lower the TFI score and ensure more integrated, consistent, and interoperable platform operations.	

3.2.5.1.7 KPI-VSA-SEC-FED-CL4 - Federation Index

Table 3-212: KPI-VSA-SEC-FED-CL4 – Federation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.75			0.83	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
FED formula: Number of components using IAM / Total number of components		CL4 architecture documentation	Enumeration of all CL4 components; classification of each component as protected or not		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.5.1.8 KPI-VSA-SEC-E2E-API-PROT-CL4 - End-to-end API protection Index

Table 3-213: KPI-VSA-SEC-E2E-API-PROT-CL4 – End-to-end API protection Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
E2E-API-PROT formula: Σ (Number of application APIs protected by gateway or service mesh) / Total number of application APIs in end-to-end process	CL4 architecture documentation	Verification of protection mechanism for each API interface across all CL4 domains		Once per assessment period	
Risk Management					
Identified Risk(s)		**Risk Mitigation Plan**			
Significant number of APIs are not protected, increasing exposure to security vulnerabilities.		Increase API protection coverage applying consistent security mechanisms such as access control, and request validation across all end-to-end interactions.			

3.2.5.1.9 KPI-VSA-SEC-E2E-API-AUTH-CL4 - End-to-end API authentication Index

Table 3-214: KPI-VSA-SEC-E2E-API-AUTH-CL4 – End-to-end API authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0.75			0.75	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
E2E-API-AUTH formula: Σ (Number of application APIs with authentication or	CL4 architecture documentation	Verification of protection mechanism for each API interface across all CL4 domains		Once per assessment period	

authorization) / Total number of application APIs in end-to-end process			
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Significant number of APIs are not protected, increasing exposure to security vulnerabilities.		Increase API protection coverage applying consistent security mechanisms such as access control, and request validation across all end-to-end interactions.	

3.2.5.1.10 KPI-VSA-SEC-E2E-EXT-AUTH-CL4 - End-to-end outbound Authentication Index

Table 3-215: KPI-VSA-SEC-E2E-EXT-AUTH-CL4 – End-to-end outbound Authentication Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
E2E-EXT-AUTH formula: Σ (Number of authenticated calls to external systems) / Total number of calls to external systems		CL4 architecture documentation	Ratio computed across all CL4 external integrations		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
-			-		

3.2.5.1.11 KPI-VSA-SEC-E2E-EV-LOG-CL4 - End-to-end Security event logging index

Table 3-216: KPI-VSA-SEC-E2E-EV-LOG-CL4 – End-to-end Security event logging index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
E2E-EV-LOG formula: Σ (Number of security events centrally logged/monitored) / Total number of security events	Source: Kubernetes cluster event logs; OpenZiti access event logs	Inspect security events from Kubernetes and OpenZiti logs; calculate the ratio of centrally captured security events computed against total security events identified across all CL4 components	Once per assessment period
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
A low E2E-EV-LOG value indicates that security events are not consistently logged or centrally monitored, reducing visibility into incidents and limiting the ability to detect and respond to security threats in a timely manner.		Improve logging coverage by ensuring that all security events are captured and centrally monitored across systems, enabling consistent auditability, detection, and response throughout the end-to-end process	

3.2.5.1.12 KPI-VSA-SEC-DATA-ENC-CL4 – Sensitive data encryption Index

Table 3-217: KPI-VSA-SEC-DATA-ENC-CL4 – Sensitive data encryption Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1			1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
DATA-ENC formula: Number of encrypted data operations / Total number of data operations	CL4 architecture documentation: OpenZiti tunnel encryption; 5G MPN link-layer encryption	Identification of the encrypted data streams; and computation of ratio		Once per assessment period	
Risk Management					
Identified Risk(s)		**Risk Mitigation Plan**			
N/A		N/A			

3.2.5.1.13 KPI-VSA-SEC-TSI-CL4 - Total Security Index

Table 3-218: KPI-VSA-SEC-TSI-CL4 – Total Security Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	90	N/A	N/A	90	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TSI formula: 0.2 x FED + 0.2 x E2E-API-PROT + 0.2 x E2E-API-AUTH + 0.1 x E2E-EXT-AUTH + 0.1 x E2E-EV-LOG + 0.2 x DATA-ENC		Computed from the six-component security KPI tables above	Application of the TSI weighted formula using values recorded in the six component KPI tables at each assessment period		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.5.1.14 KPI-VSA-SEC-TSI-NIST-CL4 - Total Security Index by NIST

Table 3-219: KPI-VSA-SEC-TSI-NIST-CL4 – Total Security Index by NIST.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5			5	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TSI-NIST score in [0, 5] scale (0 – Non-existent, 1 – Initial, 2 – Basic, 3 – Defined, 4		Based on KPI-VSA-SEC-TSI-CL4	Mapping of the TSI score to the corresponding NIST Cybersecurity Framework maturity tier		At each evaluation phase

– Managed, 5 – Optimized)			
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
-		-	

3.2.5.1.15 KPI-VSA-AUT-TAI-CL4 - Total Automation Index

Depending on the scenario and field of business where automation needs to be quantified, one should define a set of stages where automation can be assessed individually. The following example shows how automation is quantified in a "Smart Vineyards & Sustainable Winery Ecosystems" value chain in the context of Cluster 4. Table 3-220 defines the various stages of this value chain along with the typical set of tools used per stage.

Table 3-220: Automation stages for assessing Level of Automation in CL4.

Stage Number	Stage Title	Typical tools used in stage
NOK1	Sensor Data Acquisition	MQTT, REST API
NOK2	Information persistence, storage in database	InfluxDB
NOK3	Sensor Data Ingestion	FIWARE Context Broker (NGSI-LD)
NOK4	5G Network Service Provisioning	OpenSlice, TMF638 API, Keycloak
NOK5	Energy Management — Network On/Off Scheduling (planned)	OpenSlice (planned), 5G gNB management API
NOK6	AI-Driven Energy Optimization (planned)	AI model (planned), InfluxDB, OpenSlice
NOK7	IoT Data Consumption by Partner Applications	Orion FIWARE Context Broker, NGSI-LD REST API, OpenZiti
TER1	Soil Moisture Analytics	FIWARE, OpenSlice, REST API
JIG1	IoT Data Simulation and Capture	Simulated IoT sensors, data generation scripts
JIG2	Message Brokering	RabbitMQ
JIG3	IoT Data Normalization	IoTAgent (NGSI-LD Protocol Adapter)
JIG4	Context Management	Orion Context Broker
JIG5	Historical Data Persistence	Database (time-series storage)
JIG6	Real-time Dashboard and OEE Display	Real-time Dashboard, OEE analytics module
JIG7	User and Role Management	Configuration and access control layer
RZ1	Sensor Registration and Identity Creation	IoT Sensor/Recycling Platform, EU Wallet / euID Wallet

RZ2	Sensor Status and Lifecycle Data Acquisition	IoT sensors, wearable/field sensors, REST API, MQTT/event stream
RZ3	Lifecycle Monitoring and Trigger Detection	FIWARE/NGSI-LD, IoT Sensor/Recycling Platform API
RZ4	Lifecycle Monitoring and Trigger Detection	Sensor Lifecycle Manager, recycling workflow engine, dashboard rules
RZ5	Maintenance, Recovery and Recycling Workflow Management	Recycling dashboard, logistics/recycling workflow module, supplier/recycler interface
RZ6	Trusted Lifecycle Traceability and Audit Record	EU Wallet Service, wallet connector, lifecycle event records, audit logs

Next, Table 3-221 assigns an automation level from Table 2-14 to each automation stage.

Table 3-221: Automation levels per stages for assessing Level of Automation in CL4.

Stage Title	Automation level as per 3GPP
Sensor Data Acquisition	5
Information persistence, storage in database	5
Sensor Data Ingestion	5
5G Network Service Provisioning	4
Energy Management — Network On/Off Scheduling (planned)	2
AI-Driven Energy Optimization (planned)	1
IoT Data Consumption by Partner Applications	3
Soil Moisture Analytics	3
(JIG) IoT Data Simulation and Capture	5
Message Brokering	5
IoT Data Normalization	5
Context Management	5
Historical Data Persistence	5
Real-time Dashboard and OEE Display	4
User and Role Managemen	3
(RZ) Sensor Registration and Identity Creation	4
Sensor Status and Lifecycle Data Acquisition	5

Lifecycle Data Ingestion and Normalisation	5
Lifecycle Monitoring and Trigger Detection	4
Maintenance, Recovery and Recycling Workflow Management	3
Trusted Lifecycle Traceability and Audit Record	4

Moreover, Table 3-222 associates each automation stage with a weighted impact as not all stages exhibit the same importance in this specific value chain.

Table 3-222: Impact weight per stage for assessing Level of Automation in CL4.

Stage Title	Impact Weight
Sensor Data Acquisition	1
Information persistence, storage in database	1
Sensor Data Ingestion	1
5G Network Service Provisioning	3
Energy Management — Network On/Off Scheduling (planned)	4
AI-Driven Energy Optimization (planned)	4
IoT Data Consumption by Partner Applications	2
Soil Moisture Analytics	4
(JIG) IoT Data Simulation and Capture	1
Message Brokering	1
IoT Data Normalization	2
Context Management	2
Historical Data Persistence	1
Real-time Dashboard and OEE Display	3
User and Role Managemen	2
(RZ) Sensor Registration and Identity Creation	3
Sensor Status and Lifecycle Data Acquisition	3
Lifecycle Data Ingestion and Normalisation	3
Lifecycle Monitoring and Trigger Detection	4
Maintenance, Recovery and Recycling Workflow Management	4
Trusted Lifecycle Traceability and Audit Record	4

Based on the above information and the formula to measure "Total Automation Index" KPI, we derive the following values for this index in Table 3-223.

Table 3-223: KPI-VSA-AUT-TAI-CL4 – Total Automation Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	74			80	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TAI = [$\Sigma(w_i \times l_i)$ / (5 × Σw_i)] × 100, where w_i is the impact weight of stage i and l_i is the 3GPP automation level (0–5) of stage i		System deployment logs, operational records, and pilot evaluation reports	Each operational stage is assessed against the 3GPP automation level scale (0–5). The weighted average is computed using the impact weights defined in Table 3134 and normalised to a 0–100 index.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Automation level of some stages may remain below target if human-in-the-loop configuration is retained as default in operational scenarios beyond the pilot phase.			Configurable actuation mode (automatic vs. human-confirmed) is built into the architecture. Target level reflects the technically achievable maximum within the pilot scope. Demonstrated zero-touch capability is documented even if human confirmation remains the operational default.		

3.2.5.1.16 KPI-VSA-AUT-TAI-3GPP-CL4 – Total Automation Index by 3GPP

Having measured "Total Automation index" in Table 3-223, we use Table 2-19 to map this index to 3GPP automation levels, thus measure the equivalent KPI shown in Table 3-224.

Table 3-224: KPI-VSA-AUT-TAI-3GPP-CL4 – Total Automation Index by 3GPP.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	4			4	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

TAI-3GPP formula: Based on Table 2 19	KPI-VSA-AUT-TAI-CL4	Table to map KPI-VSA-AUT-TAI-CL4 to KPI-VSA-AUT-TAI-3GPP	At each evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.2.5.1.17 KPI-VSA-PIS-COV-CL4 - Total covered area

Table 3-225: KPI-VSA-PIS-COV-CL4 – Total covered area.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
	54.002 km^2			54.002	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Sum of IoT domain area in km^2 across all CL4 domains		CL4 architecture documentation	Manual measurement of IoT device deployment footprint per domain		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.5.1.18 KPI-VSA-PIS-REG-CNT-CL4 - Geographic dispersion

Table 3-226: KPI-VSA-PIS-REG-CNT-CL4 – Geographic dispersion.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	6			6	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

REG-CNT formula: Number of distinct geographic regions in your cluster	CL4 cluster architecture documentation	Distinct geographic regions with active CL4 infrastructure deployments: Matanza de Soria (Nokia 5G site), Logroño (La Rioja) – JIG, ONE site, TER site, RZ site	Once per assessment period
Risk Management			
Identified Risk(s)	**Risk Mitigation Plan**		
Geographic region count is fixed at 5 for the duration of the project; no risk of change unless a partner relocates infrastructure	N/A		

3.2.5.1.19 KPI-VSA-PIS-DOM-CNT-CL4 - Domain count

Table 3-227: KPI-VSA-PIS-DOM-CNT-CL4 – Domain count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	6			6	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
REG-CNT formula: Number of distinct geographic regions in CL4	CL4 cluster architecture documentation; cop-pilot platform domain registry	Distinct administrative domains registered in the COP-PILOT platform across CL4, based on the cluster architecture		Once per assessment period	
Risk Management					
Identified Risk(s)		**Risk Mitigation Plan**			
Domain count may increase if new partner infrastructure is added through Open Calls		Domain additions documented and flagged at each assessment period			

3.2.5.1.20 KPI-VSA-PIS-DEV-CNT-CL4 – Device count

Table 3-228: KPI-VSA-PIS-DEV-CNT-CL4 – Device count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	135			135	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Σ (device count × weight) DEV-CNT Weights Simple sensor = 1 Smart sensor = 2 Gateway = 5 5G cell = 8 Edge compute node = 10 Cloud compute node = 15		Number of devices and infrastructure in use.	Sum of number of devices considering their type and weight.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low DEV-CNT value indicates limited device deployment or insufficient infrastructure capacity, which may reduce data availability, processing capability, and overall system scalability.			Increase the number (and diversity if needed) of deployed devices across domains, ensuring sufficient coverage and capacity to support scalable data collection, processing, and service delivery.		

3.2.5.1.21 KPI-VSA-PIS-APP-CNT-CL4 - Application count

Table 3-229: KPI-VSA-PIS-APP-CNT-CL4 – Application count.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**

0	6			6	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Sum of number of applications in Cluster		Applications developed and available **Nokia expects to add 2 more OpenSlice services in UC4.4**	Count of applications developed and in use		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
A low APP-CNT value indicates a limited number of applications in the cluster, which may reduce functional coverage and limit the ability to support diverse end-to-end processes across domains.			Increase the number of applications/use cases by onboarding additional services across domains, ensuring broader functionality and improved support for integrated end-to-end operations.		

3.2.5.1.22 KPI-VSA-PIS-PROTO-CNT-CL4 - IoT Protocol diversity

Table 3-230: KPI-VSA-PIS-PROTO-CNT-CL4 – IoT Protocol diversity.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5			5	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
PROTO-CNT formula: Number of communication protocols in use		CL4 cluster architecture documentation	All communication protocols actively used across CL4 field and platform domains: MQTT, HTTPS/REST, 5G-NR, NGSI-LD, OpenZiti overlay (mTLS).		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Integrated protocols may become outdated for specific domains	Adopt newly standardized protocols

3.2.5.1.23 KPI-VSA-PIS-TIS-CL4 – Total Infrastructure Scale Index

Table 3-231: KPI-VSA-PIS-TIS-CL4 – Total Infrastructure Scale Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	6.74			6.74	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
TIS formula: log10(COV x REG-CNT x DOM-CNT x DEV-CNT x APP-CNT x PROTO-CNT		Computed from the six component PIS KPI tables above.	TIS formula using values recorded in the component PIS KPI tables at each assessment period.		Once per assessment period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.2.5.1.24 KPI-VSA-NAP-AV-CL4 – Network Availability

Table 3-232: KPI-VSA-NAP-AV-CL4 – Network Availability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
100%	100%			95%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Direct extraction of statistics from the ping utility. For availability: (Received packets / Transmitted packets) * 100	Console output from the ping network utility executed from the UPF in the 5G network core to the IP addresses of the terminal UEs connected to the sensors.	At each evaluation phase	Continuous during the testing and validation windows.
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail.		Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. Network availability can only be measured when the gNB is powered on. Regardless, in case the connection is unavailable when sending the data, the sensors have an SD card that stores it and a battery that is constantly recharged by a solar panel, as well as logic that periodically retries sending the data.	

3.2.5.1.25 KPI-VSA-NAP-LAT-CL4 - Network Latency

Table 3-233: KPI-VSA-NAP-LAT-CL4 – Network Latency.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
19 ms	19,742 ms			< 25 ms	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Direct extraction of statistics from the ping utility. For latency: Average Round Trip Time (avg rtt) in milliseconds.	Console output from the ping network utility executed from the UPF in the 5G network	Execution of continuous and automated ping command sequences from the UPF in the core of the 5G network to the UEs, gathering and logging the statistical summary generated at the end of the run.	At each evaluation phase

	core to the IP addresses of the terminal UEs connected to the sensors.		
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.		Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. Network latency can only be measured when the gNB is powered on.	

3.2.5.1.26 KPI-VSA-NAP-RATE-CL4 – Network Delivery Rate

Table 3-234: KPI-VSA-NAP-RATE-CL4 – Network Delivery Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
50 Mbit/s	52.3 Mbit/s			> 45 Mbit/s	ACHIEVED
KPI Methodology					
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**	
Direct extraction of the Bitrate metric provided by the iperf3 network testing tool. The tool calculates the smoothed mean of differences between consecutive transit times during a TCP test.	Console output and statistical summary from the iperf3 utility (running in TCP client mode) executed from the UEs in the 5G network targeting the	Execution of an automated iperf3 TCP bandwidth test (configured over a 60-second duration) from the UEs in the 5G network to the UPF’s IP address (averaged).		At each evaluation phase	

	UPF's IP address.		
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.		Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. Network bitrate can only be measured when the gNB is powered on.	

3.2.5.1.27 KPI-VSA-NAP-PLR-CL4 - Packet Loss Rate

Table 3-235: KPI-VSA-NAP-PLR-CL4 – Packet Loss Rate.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	0.77%			< 5%	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Direct extraction of the Lost/Total Datagrams metric provided by the iperf3 network testing tool. Calculated mathematically as: (Lost Datagrams / Total Transmitted Datagrams) * 100, expressed as a percentage.		Console output and statistical summary from the iperf3 utility (running in UDP client mode) executed from the UEs in the 5G network targeting the UPF's IP address.	Execution of an automated iperf3 UDP bandwidth test (configured over a 60-second duration and sending datagrams at 30Mbits/sec) from the UEs in the 5G network to the UPF's IP address (averaged). The tool actively monitors the stream, counting the total number of UDP datagrams transmitted and successfully received, identifying any missing packets.		At each evaluation phase
Risk Management					

Identified Risk(s)	Risk Mitigation Plan
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.	Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. Network jitter can only be measured when the gNB is powered on.

3.2.5.1.28 KPI-VSA-NAP-JIT-CL4 - Network Delivery Rate

Table 3-236: KPI-VSA-NAP-JIT-CL4 – Network Jitter.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
19 ms	19.7245 ms			< 50 ms	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Direct extraction of the Jitter metric provided by the iperf3 network testing tool. The tool calculates the smoothed mean of differences between consecutive transit times during a UDP test.		Console output and statistical summary from the iperf3 utility (running in UDP client mode) executed from the UEs in the 5G network targeting the UPF's IP address.	Execution of an automated iperf3 UDP bandwidth test (configured over a 60-second duration) from the UEs in the 5G network to the UPF's IP address (averaged).		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.	Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. Network jitter can only be measured when the gNB is powered on.

3.2.5.1.29 KPI-VSA-NAP-REL-CL4 – Network Reliability

Table 3-237: KPI-VSA-NAP-REL-CL4 – Network Reliability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0.1% within 16.734 ms	0.1% within 16.734 ms			> 99% within < 100 ms	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Direct extraction of the Lost/Total Datagrams metric provided by the iperf3 network testing tool, calculated mathematically as indicated in KPIs "Packet Loss Rate". Direct extraction of latency statistics from the ping utility: Average Round Trip Time (avg rtt) in milliseconds.	Console output and statistical summary from the iperf3 utility (running in UDP client mode) executed from the UEs in the 5G network targeting the UPF's IP address.	Joint execution of an automated iperf3 UDP bandwidth test (configured over a 60-second duration and sending datagrams at 30Mbits/sec) from the UEs in the 5G network to the UPF's IP address (averaged), and continuous and automated ping command sequences from the UPF in the core of the 5G network to the UEs. The tool actively monitors the stream, counting the total number of UDP datagrams transmitted and successfully received, identifying any missing packets. It also gathers the statistical summary generated at the end of the ping run.	At each evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.	Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. Network jitter can only be measured when the gNB is powered on.

3.2.5.1.30 KPI-VSA-NAP-RSRP-CL4 - Reference Signal Received Power

Table 3-238: KPI-VSA-NAP-RSRP-CL4 – Reference Signal Received Power.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
-97 dBm	-97 dBm			> -100 dBm	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Statistical aggregation: Median (50th percentile) of the registered samples from the 5G network UEs to which the sensors are connected.	Influx database containing data obtained periodically from the execution of engineering commands on 5G modems	Extract RSRP data from the Influx database for the 5G modems to which the sensors are connected, for the last 6 months. Obtain the median (50th percentile) of all the data.	At each evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet	Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.

the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.	RSRP can only be measured when the gNB is powered on. In any case, during the RSRP measurement period (6 months) enough samples are expected to be collected to obtain a statistically valid indicator.

3.2.5.1.31 KPI-VSA-NAP-RSRQ-CL4 – Reference Signal Received Quality

Table 3-239: KPI-VSA-NAP-RSRQ-CL4 – Reference Signal Received Quality.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
-10 dB	-10 dB			> -13 dB	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Statistical aggregation: Median (50th percentile) of the registered samples from the 5G network UEs to which the sensors are connected.		Influx database containing data obtained periodically from the execution of engineering commands on 5G modems	Extract RSRQ data from the Influx database for the 5G modems to which the sensors are connected, for the last 6 months. Obtain the median (50th percentile) of all the data.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.			Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. RSRQ can only be measured when the gNB is powered on. In any case, during the RSRP measurement period (6 months) enough samples are expected to be collected to obtain a statistically valid indicator.		

3.2.5.1.32 KPI-VSA-NAP-SINR-CL4 - Signal-to-Interference-plus-Noise Ratio

Table 3-240: KPI-VSA-NAP-SINR-CL4 – Signal-to-Interference-plus-Noise Ratio.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
22 dB	22 dB			> 19 dB	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Statistical aggregation: Median (50th percentile) of the registered samples from the 5G network UEs to which the sensors are connected.		Influx database containing data obtained periodically from the execution of engineering commands on 5G modems	Extract SINR data from the Influx database for the 5G modems to which the sensors are connected, for the last 6 months. Obtain the median (50th percentile) of all the data.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The main risk, aside from potentially very adverse weather conditions that could significantly affect the quality of the radio link, is the inability to meet the gNB's energy demands with renewable energy sources (solar panels and wind turbine), which could cause the node to fail. For this reason, and depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries.			Depending on the time of year, it is necessary to adjust the equipment's power on and off according to the energy available in the batteries. SINR can only be measured when the gNB is powered on. In any case, during the RSRP measurement period (6 months) enough samples are expected to be collected to obtain a statistically valid indicator.		

3.2.5.2 *Evaluation of Cluster 4-specific Business Indicators*

Table 3-241: KPI-VSS-CL4-1 - Recovery rate for IoT sensors.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0% formalised recovery rate for vineyard IoT sensors	N/A Not yet measurable. UC4.1 platform capabilities and service model are under development; pilot execution is planned for the next phase			80% recovery rate for IoT sensors within the defined lifecycle, where sensors are either reused, refurbished or recycled	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Recovery rate (%) = Number of sensors recovered for reuse, refurbishment, or recycling / Number of sensors reaching end-of-use × 100		RedZinc recycling platform logs; euID wallet lifecycle events; sensor recovery records; supplier/recycling partner confirmation records	Each sensor reaching end-of-use is registered in the platform, linked to a wallet event, and classified as reused, refurbished, recycled, or discarded.		At each pilot evaluation phase and after each sensor recovery/recycling cycle
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Limited number of sensors may reach real end-of-life during the project timeframe; physical recycling workflows may not be fully executed during early pilots.			Use controlled pilot batches and simulated lifecycle events where required; record recovery/reuse/recycling actions through platform and wallet evidence; validate the workflow first with representative devices.		

Table 3-242: KPI-VSS-CL4-2 - Water Use Optimisation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	0 %			≥20%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(current_water_usage – optimised_water_usage) / current_water_usage		Water consumption record	Compare water use before and after using Aquaview insights		Continuously monitored when Aquaview is used
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Irrigation may vary depending on external factors not linked with information provided by the system			Compare water on similar "climatic periods" and not based on calendar		

Table 3-243: KPI-VSS-CL4-3 - Enhanced application usability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No digital OEE monitoring; fully manual data collection; no system integration.	IoT Wine Platform operational and COP-PILOT integration validated (Pilot-2, Vilafranca del Penedès, March 2026). Dashboard accessibility 93.75%; anomaly			≥80% user satisfaction 100% OEE features operational ≥95% dashboard accessibility	ACHIEVED

	detection - 95.6%; downtime - 71.5%; waste - 52.5%; 47.3 MWh/year saved. IoT simulated at M17.				
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Survey results (% positive responses); operational metrics from certification letter; COP-PILOT integration validation.		Pilot-2 survey (16 participants); 3 stakeholder interviews; Bodegas Franco-Españolas signed certification letter (17/03/2026); platform demo evidence.	Gamified survey, structured interviews, certification letter, video evidence.		At each evaluation milestone (M17, M25, M33).
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Variable digital maturity across target wineries; resistance to replacing existing tools.			Complementary integration approach; phased deployment; training programme.		

Table 3-244: KPI-VSS-CL4-4 - Ground Infrastructure Reduction.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
≥2	1			≤2	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Number of used sensors	Sensor usage record	Evaluate number of physical sensors used to generate analytics results	Collect information in farms where sensors are used
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

Table 3-245: KPI-VSS-CL4-5 - Water Consumption Reduction.

KPI across project evaluation phases						
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**		**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	Not measured yet				≥20%	NOT ACHIEVED
KPI Methodology						
Measurement Calculation Formula		**Measurement Input Source**		**Measurement Collection Process**		**Measurement Collection Frequency**
(current_water_usage – optimised_water_usage) / current_water_usage		Water consumption record Yield record	Compare water use before and after using Aquaview insights without loss of yield	Continuously monitored when Aquaview is used		
Risk Management						
Identified Risk(s)				**Risk Mitigation Plan**		
Irrigation and obtained yield may vary depending on external factors not linked with information provided by the system		Compare water and yield on similar "climatic periods" and not based on calendar				

Table 3-246: KPI-VSS-CL4-6 - Soil Health Monitoring Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	100 %			100 %	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
data_retained / data_recorded		Soil moisture data	Record of new users on board without external support		Measured during pilots or for Aquaview users
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-247: KPI-VSS-CL4-7 - Stakeholder Inclusivity Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1	3			≥2	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of supported languages		Record of supported language	Languages on Gamaya Platform		Always shown on Platform
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-248: KPI-VSS-CL4-8A - Energy Efficiency Gain.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	28.5 %			≥30 %	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(current_cloud_usage – optimised_cloud_usage) / current_cloud_usage		Cloud resources consumption record	Evaluate Virtual machine on cloud costs with the two versions of the system (using edge devices or not)		Once for the whole system
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The VM usage can vary depending on the activity of the customers making the reduction of cloud resources important depending on the number of flights they do			Evaluation on average on several partners		

Table 3-249: KPI-VSS-CL4-8B - Energy Efficiency Gain.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	97.92%, 58.33%, 0.00%, 58.33%			≥30 %	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(current_*5g-radio-backend*_usage – optimised _*5g-radio-backend* _usage) /		5g radio site and backend resources consumption records	Continuous measurement of energy consumption		Once per minute

current _*5g-radio-backend* _usage			

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
The consumption is changing depending on when the site is configured for saving energy or not, and also on weather conditions	Evaluation in four different periods: Winter, Spring, Summer, Fall.

Value	Power in watts	Winter Hours	Spring Hours	Summer Hours	Fall Hours
Period		Winter	Spring	Summer	Fall
5G radio and backend power site on watts	800				
5G radio and backend power site off watts	124				
5G radio and backend power site on hours per day		0.5	10	24	10
5G radio and backend power site off hours per day		23.5	14	0	14

During Summer, the site do not requires energy saving because of sun availability. Then the site consumes 19200 watts per day.

Value	Power in watts	Winter Hours	Spring Hours	Summer Hours	Fall Hours
Total Energy site on watts per day		400	8000	19200	8000
Total Energy site off watts per day		62	1240	2976	1240
Total Energy watts per day		462	9240	22176	9240

The other periods is saving energy with defined fixed configurations. The KPIs for the energy savings are the following:

Value	Power in watts	Winter Hours	Spring Hours	Summer Hours	Fall Hours
KPI Energy Saving		97.92%	58.33%	0.00%	58.33%

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
No energy monitoring on production line; no baseline measurement available.	47.3 MWh/year saved through real-time production monitoring and anomaly detection on bottling line (Bodegas Franco-Españolas certification letter, 17/03/2026).			≥30 %	ACHIEVED

KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Energy savings (MWh/year) = baseline energy consumption – post-deployment energy consumption.		Bodegas Franco-Españolas internal production systems; signed certification letter (17/03/2026).	Comparison of energy consumption records before and after UC4.3 deployment; independently verified by winery.		At each evaluation milestone.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Energy savings depend on production volumes which may vary across seasons.			Compare equivalent production periods; use certified winery records as primary evidence source.		

Table 3-250: KPI-VSS-CL4-9 - GDPR Compliance Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
100% compliance audit readiness.	100% compliance audits passed.			100% compliance audits passed.	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compliance score = (passed audits / total audits) × 100.		Audit and documentation records.	Review of compliance checks, documented evidence and audit outcomes against GDPR requirements.		At project milestones and audit cycles, as required.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Incomplete documentation or missing audit evidence may affect the final compliance score.	Maintain updated records, review data-handling procedures regularly and verify compliance evidence before each audit.

Table 3-251: KPI-VSS-CL4-10 - User Satisfaction Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	90.9 %			≥80 %	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of persons with positive feedback / Number of persons		Rating	User surveys during pilots		For each pilot
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Audience may not be used to digital platform			Demonstration and explanation during the different events to educate audience		

Table 3-252: KPI-VSS-CL4-11 - System Affordability Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	N/A			≥50 %	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(Cost for normal user – cost for new user) / cost for normal user		Cost for different users	Implementation cost record		All along the project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

Get enough new users to have a reliable measurement	Organize events to promote solution

Table 3-253: KPI-VSS-CL4-12 - Scalability Performance Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Solution successfully deployed in the initial pilot context but 0% scalability readiness.	50% scalability readiness and documentation prepared for reuse in additional contexts.			100% scalability readiness. Possibility to replicate the solution in at least 3 EU countries and extend it to 1+ additional process, based on scalability reports generated from the deployment environment.	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Scalability readiness = assessment of the solution's ability to be replicated in new countries/processes.		Implementation records, deployment reports, configuration templates and documentation.	Review of evidence to confirm the solution can be scaled or adapted to other contexts.		At each scalability review.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Differences in local infrastructure, regulatory conditions, or process requirements may slow down replication.			Use a standardized deployment architecture, reusable templates and documented implementation procedures to support adaptation in new contexts.		

Table 3-254: KPI-VSS-CL4-13 – Integration and Maintenance Efficiency Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	N/A			≥40 %	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Reduction in time to integrate new users		Cost and time	Integration time records		For each new integrated partner
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-255: KPI-VSS-CL4-14 - Cost Savings.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	28.5 %			≥30 %	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(current_cloud_cost – optimised_cloud_cost) / current_cloud_cost		System Costs	Budgetary records, cost breakdown before/after implementation		Average over different users for the whole system
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-256: KPI-VSS-CL4-15 - Profitability Index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	N/A			≥10 %	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(new_profitability – old_profitability) / old_profitability		Profitability of users	Budgetary records, cost breakdown before/after implementation		At the end of the project on average on all integrated users
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Solution is not operationally used to measure effects on profitability			Find a reduced number of partners that implemented and used the solution instead of evaluating on all		

Table 3-257: KPI-VSS-CL4-16 - Data Management Quality Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	100 %			≥95 %	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Downtime / uptime		System downtime record	Total downtime according to the uptime logs		Evaluated all along the project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-258: KPI-VSS-CL4-17 - Asset lifecycle improvement.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Existing solution already operational with limited automated data reading and partial data coverage (40%)	Platform running at local pilot level with main technical components connected and initial data flow validated (70%)			Full integration with COP-PILOT ecosystem, broader interoperability and complete operational collaboration layer. (95%)	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Percentage of connected data sources and integrated operational components over total planned components.	Existing platform logs, orchestration data, device readings, integration status reports and pilot validation records.	Review of platform connectivity, data ingestion and operational validation	Continuous technical monitoring, with formal assessment at each evaluation milestone.

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Incomplete integration may prevent full lifecycle data capture and reduce measurement accuracy.	Progressively extend the existing solution by integrating additional data sources and COP-PILOT components, validate the platform in pilot conditions and confirm interoperability step by step before final consolidation.

Table 3-259: KPI-VSS-CL4-18 - Waste reduction (%).

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Existing production and IoT setup in place, with limited visibility on waste generation and defect pattern (0% reduction).	10% reduction Initial monitoring of production sensor records and defect tracking available within the pilot environment.			≥50% reduction of IoT device e-waste; 15% decrease in defective products based on production sensor records, quality control reports and the defect tracking system integrated into COP-PILOT.	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(Initial value - Current value) / Initial value × 100	Production sensor records, quality control reports, defect tracking system integrated into COP-PILOT.	Automatic capture and comparison of production data, quality outcomes and defect logs against baseline records.	Continuous technical monitoring, with formal assessment at each evaluation milestone.

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Incomplete baseline data or partial integration may limit the reliability of waste and defect reduction measurements.	Consolidate production and defect data capture, validate reports against baseline records and compare results across pilot phases.

Table 3-260: KPI-VSS-CL4-19 - Social Equity Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
60% dashboard and role management coverage, with limited multilingual support and limited user-specific views.	75% dashboard and role management coverage, with multilingual support partially enabled and user-specific views validated for the main user groups.			90% dashboard and role management coverage, with fully enabled multilingual support and user-specific views available for all target user roles.	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
User satisfaction / accessibility score based on survey results and validated role-based usage coverage.		User role system logs and monitoring of language and accessibility preferences.	Review of platform usage, role access logs, language selection data and user survey responses.		At project milestones and after user testing sessions.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Limited user adoption or incomplete testing across roles and languages may reduce the reliability of the accessibility score.			Validate the dashboard with representative user roles, test all language and UI/UX variants and collect structured feedback during pilot sessions.		

Table 3-261: KPI-VSS-CL4-20 - Workforce productivity index.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**

100% manual data entry and repetitive monitoring tasks were part of the normal workflow.	Automated monitoring and data capture already integrated into the platform workflow (80%).			25% reduction in manual data entry based on automated task system logs.	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Reduction (%) = (baseline manual data entry - current manual data entry) / baseline manual data entry × 100.		Manual entry data record and automated task system logs.	Compare manual workload before and after automation using system logs and workflow records.		Continuous, with formal review at each evaluation milestone.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Partial automation coverage may limit the reduction in manual data entry.			Extend automation to additional repetitive tasks and verify reductions against baseline manual records.		

Table 3-262: KPI-VSS-CL4-21 - Workforce upskilling rate (%).

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0% cost reduction.	70% cost reduction.			30% reduction in operational costs based on a before-and-after comparison using accounting records and ERP reports.	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Cost reduction (%) = (baseline operational costs - current operational costs) / baseline operational costs × 100	Budgetary records, cost breakdown before/after implementation, accounting records and ERP reports.	Compare pre- and post-implementation cost data, using accounting and ERP evidence to validate savings.	At project milestones and during financial review cycles.
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Cost changes may be influenced by external factors or incomplete baseline accounting data.		Use consistent accounting categories, compare equivalent periods and validate savings against ERP reports and budget records.	

Table 3-263: KPI-VSS-CL4-22 – Interoperability Score.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Partial integration achieved (40%).	Advanced integration achieved (70%).			Full integration achieved (100%)	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Interoperability score = validated integration functions / total planned integration functions × 100.		Documented ERP/MES integration tests, successful API call logs and validated system connectivity records.	Run and review integration tests, verify API responses and confirm stable data exchange between systems.		At each integration milestone and interoperability review.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Differences in ERP/MES configurations or API incompatibilities may limit full interoperability.			Test interfaces early, align data structures and middleware and validate connectivity step by step with each external system.		

3.2.5.3 Converted Business Value for Cluster 4

Table 3-264: KVI-VSS-CL4-1: Water Use Optimisation.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	0 %			≥ 20%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-2					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-265: KVI-VSS-CL4-2: Reduction of Ground Infrastructure.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
≥ 2	1			≤ 2	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-4					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-266: KVI-VSS-CL4-3: Water Use Efficiency.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	0 %			≥ 20%	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-5					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-267: KVI-VSS-CL4-4: Long-Term Soil Health Monitoring.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	100 %			100 %	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-6					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-268: KVI-VSS-CL4-5: Ease of Use.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	90.9 %			≥ 80 %	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-7					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-269: KVI-VSS-CL4-6: Energy Efficiency.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	53.65%			40%	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Average for the whole year of KPI-VSS-CL4-8 value		Calculated using the constantly KPI measurements with average availability	KVI can be calculated by using a whole year project. Can be calculated constantly per fixed period.		Calculated as required because KPIs are stored in project storage
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
The total value calculates the saving of green energy in Nokia Matanza site. The value could be optimized to save energy even in summer if required. This value meaning should consider other requirements like source of energy and			We are evaluating the definition of new KVIs to understand different energy resources availabilities and implications		

Table 3-270: KVI-VSS-CL4-7: Data Privacy Trust.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
100 % compliance audit readiness	N/A			100 % compliance audits passed	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-9					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-271: KVI-VSS-CL4-8: User Satisfaction Improvement.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	90.9 %			≥ 80 %	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-10					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-272: KVI-VSS-CL4-9: System Scalability.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
Solution successfully deployed in the initial pilot context but 0% scalability readiness.	50% scalability readiness and documentation prepared for reuse in additional contexts.			100% scalability readiness. Possibility to replicate the solution in at least 3 EU countries and extend it to 1+ additional process, based on scalability reports generated from the deployment environment.	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-12					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-273: KVI-VSS-CL4-10: Scalable Architecture.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	N/A			≥ 40 %	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-13					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-274: KVI-VSS-CL4-11: Operational Cost Savings.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	N/A			≥ 30 %	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-14					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-275: KVI-VSS-CL4-12: Profitability & Competitiveness.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	N/A			≥ 10 %	NOT ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-15					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-276: KVI-VSS-CL4-13: Robust Data Management.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 %	100 %			≥ 95 %	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-16					
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

Table 3-277: KVI-VSS-CL4-14: Sustainable Winery Production.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
4.2 hours per incident 100% of anomaly monitoring and detection was performed manually by operators, requiring an average of 4.2 hours per incident.	11 minutes per incident (−95.6%) Automated detection reduced average operator time per incident to 11 minutes.			25% reduction in manual data entry and repetitive monitoring tasks	ACHIEVED

KVI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
KPI-VSS-CL4-20	ERP/MES system logs and JIG platform event records.	Comparison of manual data entry events and operator-triggered monitoring checks registered in the ERP/MES and JIG platform before and after deployment.	Once per pilot evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

Table 3-278: KVI-VSS-CL4-15: Digital Transformation MES.

KVI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0% OEE functionality and dashboard accessibility.	95%			85%	ACHIEVED
KVI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
KPI-VSS-CL4-3		Functional verification checklist of deployed UC4.3 platform features (OEE monitoring, real-time dashboards, user management) and validated by Bodegas Franco-Españolas.	Technical verification of the deployed platform functionalities.		Once per pilot evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.3 Impact on Scientific Community

3.3.1 KPI-SCI-1 - Number of academic publications on edge computing (mid-term)

This KPI is partially covered by KPI-DIS-1 (see Section 3.9.1) and KPI-DIS-2 (see Section 3.9.2).

It is hard to provide an estimate on the expected academic publications on edge computing within 1-2 years after the end of the project.

3.3.2 KPI-SCI-2 - Number of research papers (mid-term)

This KPI is partially covered by KPI-DIS-1 (see Section 3.9.1) and KPI-DIS-2 (see Section 3.9.2).

It is hard to provide an estimate on the number of research papers within 1-2 years after the end of the project.

3.3.3 KPI-SCI-3 - Number of projects capitalizing on COP-PILOT assets (long-term)

Table 3-279: KPI-SCI-3 – Number of projects capitalizing on COP-PILOT assets (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (1 year after the end of the project)**		**Assessment Result**
N/A	10		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Count number of project using COP-PILOT components, including Open Call projects	COP-PILOT partners and Open Calls	WP4 and WP6 reports	At end of project and then annually
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited interest (low probability as COP-PILOT partners expressed their interest in further using them)		Adjust dissemination and communication plans (for external users)	

3.4 Impact on Economy

3.4.1 KPI-ECO-1 - Number of partnerships (mid-term)

Table 3-280: KPI-ECO-1 – Number of partnerships (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (1 year after the end of the project)**		**Assessment Result**
N/A yet	10		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Count connection with the industry	COP-PILOT Partners	Questionnaires	At end of project and one year after
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited interest		Adjust dissemination and communication plans to pursue industrial connections)	

3.4.2 KPI-ECO-2 - Adoption rate (mid-term)

Table 3-281: KPI-ECO-2 – Adoption rate (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (2 years after the end of the project)**		**Assessment Result**
N/A yet	50%		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(Deployments (2 years after the end of the project) – Deployments (at project completion)) / Deployments (at project completion) × 100%	COP-PILOT partners, tool owners, tool repositories	Questionnaires	At end of project and two years after
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited interest in adoption		Adjust dissemination and communication plans	

3.4.3 KPI-ECO-3 - Edge computing market share (long-term)

Table 3-282: KPI-ECO-3 – Edge computing market share (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
N/A yet	20%		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(COP-PILOT deployments / total edge computing solution deployments in target vertical) × 100% (Target vertical: e.g., smart manufacturing, intelligent transport)	Industry analyst reports	Combine input from reports, Questionnaires	At end of project and then annually
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited information to measure the total deployments in verticals		Combine data from different sources	

3.4.4 KPI-ECO-4 - Adoption rate (long-term)

Table 3-283: KPI-ECO-4 – Adoption rate (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
N/A yet	400		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Count of enterprises using COP-PILOT components	Information from COP-PILOT partners, tool owners, tool repositories	Get information from COP-PILOT partners and tool repositories	At end of project and then annually
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	

Limited information to measure the exact number of enterprises	Combine data from different sources

3.4.5 KPI-ECO-5 - New businesses launched by COP-PILOT (long-term)

Table 3-284: KPI-ECO-5 – New businesses launched by COP-PILOT (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
N/A yet	30		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Count of new companies with product/service built based on COP-PILOT developed components	Information from COP-PILOT partners, tool owners, tool repositories	COP-PILOT partners and tool repositories	At end of project and then annually
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited information to measure the exact number of companies		Combine data from different sources, engage open call participants	

3.4.6 KPI-ECO-6 - Reduced OPEX (long-term)

Table 3-285: KPI-ECO-6 – Reduced OPEX (long-term).

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (3 years after the end of the project)**		**Assessment Result**
N/A yet	30%		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(OPEX before adoption – OPEX after adoption) / OPEX before adoption × 100%	End users	Questionnaires, surveys	Annually after the end of the project
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited information provided by end users		Create simple questionnaire, promote through network of partners	

3.5 Impact on Technology

3.5.1 KPI-TEC-1 - Long-term increase in deployed COP-PILOT edge solutions

Table 3-286: KPI-TEC-1 – Long-term increase in deployed COP-PILOT edge solutions.

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
	30%		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
(COP-PILOT deployments in supported edge solutions (year t+1) - COP-PILOT deployments in supported edge solutions (year t))/COP-PILOT deployments in supported edge solutions (year t) × 100%	Information from COP-PILOT partners, tool owners, tool repositories	Get information from COP-PILOT partners and tool repositories	Annually after the end of the project
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited information provided by adopters		Create simple questionnaire, promote through network of partners, engage open call participants	

3.5.2 KPI-TEC-2 - Number of interfaces and protocols tested across different clusters

Table 3-287: KPI-TEC-2 – Number of interfaces and protocols tested across different clusters.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	Total ifc: 18 Total prt: 5 Platform interfaces i5, i8-i13, i15, i17, i19-i24, i26-i28 as per D3.1 [2]			20 interfaces and protocols	ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
$\Sigma_{\text{interfaces-protocols}}$ (for every cluster)	Platform interfaces and protocols by each cluster	Platform utilization report in the context of WP4	Once in every evaluation cycle
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
N/A		N/A	

3.5.3 KPI-TEC-3 - Long-term number of edge computing solutions stemming from entrepreneurship

Table 3-288: KPI-TEC-3 – Long-term number of edge computing solutions stemming from entrepreneurship.

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
Total: N/A yet CL1: N/A yet CL2: N/A yet CL3A: N/A yet CL3E: N/A yet CL4: N/A yet	20		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Count number of new edge computing solutions	Information from COP-PILOT partners, tool owners, tool repositories	Get information from COP-PILOT partners and tool repositories	Annually after the end of the project
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Limited information provided		Create simple questionnaire, promote through network of partners, engage open call participants	

3.5.4 KPI-TEC-4 - Long-term increase in automation by reducing service provisioning time

Table 3-289: KPI-TEC-4 – Long-term increase in automation by reducing service provisioning time.

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
N/A yet	10x faster provisioning and deployment time of complex cross sector applications		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
The COP-PILOT Business Management Portal (BMP) will provide an LLM chatbot that dramatically reduces time and complexity of Product ordering and deployment	COP-PILOT BMP	Timestamp annotations in the BMP on (i) the time that an end user started to chat with the BMP chatbot and (ii) the time when the BMP finally understood what the user wants to	Periodically during phase 2 and 3

		deploy and realized is via the COP-PILOT orchestrators	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
An order of magnitude faster is probably too challenging, but not impossible		The BMP LLM may potentially be optimized towards Product Ordering especially	

3.5.5 KPI-TEC-5 - Long-term increase in QoE for end users of COP-PILOT

Table 3-290: KPI-TEC-5 – Long-term increase in QoE for end users of COP-PILOT.

KPI across project evaluation phases			
Achieved Value on M36	**Target Value (5 years after the end of the project)**		**Assessment Result**
Average: N/A yet CL1: N/A yet CL2: N/A yet CL3A: N/A yet CL3E: N/A yet CL4: N/A yet	> 4.3 according to ITU-T SG12 standard		NOT ACHIEVED
KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
QoE as per ITU-T SG12 standard	Questionnaires per Cluster	Questionnaires sent to stakeholders per Cluster	Once
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Such questionnaires are amenable to subjective opinion and/or not necessarily inline with the strict definition of QoE.		N/A	

3.6 Impact on Society

3.6.1 Cluster 1

For Cluster 1, the M17 social assessment is based on the available proxy evidence from the Cluster-specific KPIs and the social value assumptions defined in the Cluster 1 KVIs. The assessment is preliminary, since direct real-world social outcomes such as reduced accident rates cannot be validated within the current TRL6 testbed.

The main social value at M17 relates to worker safety, situational awareness and hazard alerting. For KVI-VSS-CL1-2.4, Worker safety in tunnel inspections, KPI-VSS-CL1-2.5 shows progress from manual human visits to manual inspection reporting via Nucleus. This provides an initial step towards reducing the need for manual presence in potentially hazardous underground areas, although fully automated inspection reporting has not yet been demonstrated.

For KVI-VSS-CL1-2.5, Improved situational awareness of worker location, KPI-VSS-CL1-2.7 shows that positional updates have moved from manual human communication every 10 minutes to automated positional updates every 10 minutes. This provides early proxy evidence for improved situational awareness, while the target of one update every 10 seconds remains to be achieved.

For KVI-VSS-CL1-2.6, Timely hazard alerting for underground workers, KPI-VSS-CL1-2.6 shows that alarm detection and SMS alerting have been implemented with a measured latency of 30 seconds. This demonstrates initial hazard alerting capability, although further improvement is needed to reach the target of less than 10 seconds.

KVI-VSS-CL1-1.1, Improved real-time decision-making capabilities in critical situations, is not yet supported by sufficient M17 evidence, since the associated distributed compute and dynamic scaling indicators have not yet been demonstrated. However, the value remains relevant for later validation once seismic processing and edge-to-cloud scaling capabilities are further implemented.

Overall, the M17 social assessment shows early proxy evidence for improved monitoring, position awareness and hazard alerting, but does not yet validate realised social impact in operational mining environments. The assessment will be updated in later validation cycles as more functionality is implemented, technical KPI evidence matures, and additional stakeholder feedback becomes available.

3.6.2 Cluster 2

3.6.2.1 KPI-SOC-CL2-1 – User Satisfaction Improvement

Table 3-291: KPI-SOC-CL2-1 – User Satisfaction Improvement.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	50%			80%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Percentage of users rating the COP-PILOT solution positively.		Direct end-user and operator	Distribution of numerical evaluation forms (1 to 5 scale)		At each evaluation phase.

Formula: (Number of responses scoring 4 or 5 / Total responses) * 100.	satisfaction surveys, specifically comparing the "Before" (legacy processes) vs "After" (COP-PILOT platform) scenarios.	to the operational staff testing the pilot.	
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
"Risk 1: Short exposure time bias. During the initial evaluation (M17), users haven't had enough time to deeply test the solutions in their daily routines. This leads to premature evaluations where users might initially perceive the tool as not useful due to the learning curve, or vice versa. Risk 2: Natural resistance to workflow changes, keeping the perceived satisfaction artificially stagnant despite technical improvements."		Allow for a natural adoption curve. Conduct follow-up surveys once the system is fully integrated into their long-term habits. Additionally, schedule hands-on training sessions to highlight the platform's utility.	

3.6.3 Cluster 3A

3.6.3.1 KPI-SOC-CL3A-1 - Consumer Access to Safe, Traceable, and Sustainably Produced Leafy Vegetables

Table 3-292: KPI-SOC-CL3A-1 – Consumer Access to Safe, Traceable, and Sustainably Produced Leafy Vegetables.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0% BAR operated manual traceability records covering farm-to-facility steps;	30% Farm activity logs populated; Blockchain data trail initiated during Pilot 1 delivery cycles; consumer-			100% Verifiable field-to-point-of-sale transparency available for all pilot product batches through the consumer-facing	NOT ACHIEVED

consumers had no access to digital provenance information.	facing transparency scheduled for Phase 2 development.			provenance interface	
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Qualitative assessment of consumer-facing transparency (demonstrated / not demonstrated), supported by traceability coverage (%) from KVI-VSS-CL3A-2		Hyperledger Fabric transaction logs; consumer-facing provenance interface; BAR quality assurance and product labelling records	BAR validates the provenance information visible to consumers per pilot batch against its QA and labelling processes; iLink confirms completeness of the underlying blockchain records		Per pilot season; reported at each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.6.3.2 *KPI-SOC-CL3A-2 - Digital Empowerment of Contract Farmers*

Table 3-293: KPI-SOC-CL3A-2 – Digital Empowerment of Contract Farmers.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A Farmers and agronomists relied on physical field visits and manual records; contract farmers had no access to digital precision	N/A AgroApps 360 deployed across pilot plots; farmer onboarding and training initiated during Pilot 1. Labour hour quantification pending full season data			Measurable reduction in manual labour hours per farmer and per agronomist vs. baseline; pilot contract farmers actively using COP-PILOT-enhanced precision agriculture tools	NOT ACHIEVED

agriculture tools					
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Labour reduction (%) = (Hours_baseline − Hours_pilot) / Hours_baseline × 100, computed separately per farmer and per agronomist		BAR agronomist visit records; farmer task records	BAR agronomists and farmers record field visit frequency and task hours per season;		Per growing season; reported at each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Partial farmer adoption reduces measurable labour savings			BAR agronomist support programme and farmer training drive adoption		

3.6.4 Cluster 3E

3.6.4.1 KPI-SOC-CL3E-1 - Reliable Access to EV Charging and Clean Energy

Table 3-294: KPI-SOC-CL3E-1 – Reliable Access to EV Charging and Clean Energy.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	5%			≥20%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Downtime reduction (%) = (unplanned downtime hours at baseline − unplanned downtime hours post-deployment) / unplanned downtime hours at baseline × 100		Infrastructure downtime logs	Downtime events logged; post-deployment downtime logs compared against baseline at each evaluation milestone		At the end of validation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Insufficient historical downtime data at baseline may make pre/post comparison unreliable			Downtime logging initiated from early project period at both sites to build a comparable baseline before predictive maintenance is activated		

3.6.4.2 KPI-SOC-CL3E-2 - Digital Upskilling of Energy Sector Workers

Table 3-295: KPI-SOC-CL3E-2 – Digital Upskilling of Energy Sector Workers.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥2	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of operational personnel with active dashboard sessions recorded in Keycloak access logs at each evaluation milestone		Keycloak access logs; staff onboarding records	Active users defined as personnel logging into the dashboard at least once per week during the evaluation period.		At the end of validation period
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Operational staff may resist adopting new digital tools			Dedicated onboarding and training sessions planned for operational staff		

3.6.5 Cluster 4

3.6.5.1 KPI-SOC-CL4-1 - Safer and more inclusive digital field operations through trusted IoT LCM

Table 3-296: KPI-SOC-CL4-1 – Safer and more inclusive digital field operations through trusted IoT LCM.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0 Not enabled field-worker monitoring or sensor lifecycle trust mechanism	N/A Use case and pilot scenario defined; field deployment pending			≥80% positive user feedback on usability/trust and demonstrated availability of lifecycle-traceable sensors in pilot workflows	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Societal acceptance/trust score (%) = Number of positive survey responses / Total survey responses × 100. Operational support can also be evidenced by number of monitored sessions and number of lifecycle-traceable sensors	User surveys; platform usage logs; dashboard access logs; sensor lifecycle records; pilot feedback sessions	Collect feedback from vineyard operators, field workers, technical partners, and relevant stakeholders after pilot demonstrations	After each pilot and at each evaluation phase

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Limited number of pilot users may reduce statistical significance; worker monitoring scenarios may require additional privacy review	Combine quantitative platform logs with qualitative feedback; anonymise user feedback; ensure GDPR-compliant consent and data minimisation for monitoring scenarios

3.7 Impact on Standardization

3.7.1 KPI-SDO-1 - New ETSI Development Group

Table 3-297: KPI-SDO-1 – New ETSI Development Group.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
1 (ETSI HypO MDG part of OpenSlice SDG was a direct outcome of ACROSS)	2 (ETSI BSS MDG part of ETSI OpenSlice SDG is a direct outcome of COP-PILOT to create the Business Management Portal of the platform)			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Compare the number of ETSI development groups established as direct outcome of COP-PILOT versus the ACROSS EU project		ETSI OpenSlice SDG development groups since COP-PILOT started	ETSI OpenSlice MDG creation announcements		Ad-hoc, when a new MDG is created
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.7.2 KPI-SDO-2 - Updated conformance testing for ETSI NGSI-LD

Table 3-298: KPI-SDO-2 – Updated conformance testing for ETSI NGSI-LD.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>0</td><td>8

Update #1,
Update #2,
Update #3,
Update #4,
Update #5,
Update #6,
Update #7,
Update #8</td><td></td><td></td><td>>10</td><td>NOT ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">$\Sigma_{ngsi\text{-}confromance\text{-}tests}$</td><td>ETSI TC DATA documents</td><td colspan="2">ETSI TC DATA contributors and Leadership Group reports</td><td>Once in every evaluation cycle</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">N/A</td><td colspan="3">N/A</td></tr>
</table>

3.7.3 KPI-SDO-3 - ETSI TC DATA PoC#1

Table 3-299: KPI-SDO-3 – ETSI TC DATA PoC#1.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥1	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of PoCs to ETSI TC DATA		ETSI OpenSlice SDG artifacts shared since COP-PILOT started	ETSI OpenSlice SDG events and/or dissemination channels		Ad-hoc, when a reference is captured during an ETSI OpenSlice SDG event and/or dissemination channels
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.7.4 KPI-SDO-4 - ETSI SDG OSL PoC#1 - GitOps-based Service Deployments

Table 3-300: KPI-SDO-4 – ETSI SDG OSL PoC#1.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	2 (1 pre-release technical presentation, 1 presentation in 2026 SNS4SNS)			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Evaluate the number of formal presentations and validation artifacts uploaded by the ETSI SDG OSL channels		ETSI OpenSlice SDG artifacts shared since COP-PILOT started	ETSI OpenSlice SDG events and/or dissemination channels		Ad-hoc, when a reference is captured during an ETSI OpenSlice SDG event and/or dissemination channel
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.7.5 KPI-SDO-5 - ETSI SDG OSL PoC#2 - Business Layer Integration

Table 3-301: KPI-SDO-5 – ETSI SDG OSL PoC#2.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1 (1 pre-release technical presentation)			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Evaluate the number of formal presentations and validation artifacts uploaded by the ETSI SDG OSL channels		ETSI OpenSlice SDG artifacts shared since COP-PILOT started	ETSI OpenSlice SDG events and/or dissemination channels		Ad-hoc, when a reference is captured during an ETSI OpenSlice SDG event and/or dissemination channel
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.7.6 KPI-SDO-6 - Open-source contributions to ETSI OSL

Table 3-302: KPI-SDO-6 – Open-source contributions to ETSI OSL.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	20			≥40	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of relevant ETSI OSL open-source contributions made, released, documented, or integrated by UOP or other COP-PILOT partners in the context of the project. Contributions may include public repositories, merged pull requests, released components, documented integration patterns, deployment artefacts, issues, examples, or COP-PILOT-specific references linked to ETSI OSL.		ETSI OSL GitLab repositories, COP-PILOT D3.1 [2] and D3.2.	ETSI OSL GitLab boards on ETSI GitLab with acknowledgements to COP-PILOT		Periodically, before each evaluation milestone
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.7.7 KPI-SDO-7 - Potential extensions to TMF data models and APIs

Table 3-303: KPI-SDO-7 – Potential extensions to TMF data models and APIs.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1 (see issue opened by UBITECH here)			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
$\Sigma_{\text{tmf-issues-opened}}$		New post in the forum here	Filter posts here by COP-PILOT partner		Once in every evaluation cycle
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Extensions in TMF data models and/or APIs usually take long time to transition from initial discussion with the TMF community to actual contributions in the standard			The consortium has not power to make a mitigation plan, other than push for convergence via the public forum.		

3.7.8 KPI-SDO-8 - ETSI ISG ZSM Presentation

Table 3-304: KPI-SDO-8 – ETSI ISG ZSM Presentation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1 ETSI ZSM PoC#16 presentation Link to ZSM website			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of ETSI ZSM presentations that acknowledge COP-PILOT		COP-PILOT website of events	Leader of the presentation shares the material (slides, pictures) with COP-PILOT		Once
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.7.9 KPI-SDO-9 - ETSI ISG ZSM PoC#1

Table 3-305: KPI-SDO-9 – ETSI ISG ZSM PoC#1.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>0</td><td>1

ETSI ZSM PoC#16 Scenario #2 shows how the demonstrated orchestration platform onboards and orders a complex 5G video streaming service through simple portal-based operations</td><td></td><td></td><td>≥1</td><td>ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Number of ETSI ZSM PoC scenarios approved and presented as a PoC</td><td>ETSI ZSM website</td><td colspan="2">Recording of the PoC and publication to the project's website</td><td>Once when happened</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">An ETSI ZSM PoC takes time to be materialized as it requires an official proposal document, a presentation of the proposal, followed by an official approval, a scheduled event to present the PoC, and finally a PoC report.</td><td colspan="3">COP-PILOT planned this activity early on to avoid risking such a PoC towards the end of the project.</td></tr>
</table>

3.7.10 KPI-SDO-10 - ETSI ISG ZSM PoC#2

Table 3-306: KPI-SDO-10 – ETSI ISG ZSM PoC#2.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1 ETSI ZSM PoC#16 Scenario #3B shows how the demonstrated orchestration platform preserves an SLA in a totally zero-touch manner			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of ETSI ZSM PoC scenarios approved and presented as a PoC		ETSI ZSM website	Recording of the PoC and publication to the project's website		Once when happened
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
An ETSI ZSM PoC takes time to be materialized as it requires an official proposal document, a presentation of the proposal, followed by an official approval, a scheduled event to present the PoC, and finally a PoC report.			COP-PILOT planned this activity early on to avoid risking such a PoC towards the end of the project.		

3.7.11 KPI-SDO-11 - ETSI ISG ZSM PoC#3

Table 3-307: KPI-SDO-11 – ETSI ISG ZSM PoC#3.

<table>
<tr><th colspan="6">KPI across project evaluation phases</th></tr>
<tr><th>Baseline Value (M1)</th><th>Measured Value – Initial Evaluation (M17)</th><th>Measured Value – Intermediate Evaluation (M25)</th><th>Measured Value – Final Evaluation (M33)</th><th>Target Value (M36)</th><th>Assessment Result</th></tr>
<tr><td>0</td><td>1

ETSI ZSM PoC#16 Scenario #2 shows how the demonstrated orchestration platform orchestrates services and resources across distributed testbeds in Greece and Spain for an end-to-end 5G video streaming service</td><td></td><td></td><td>≥1</td><td>ACHIEVED</td></tr>
<tr><th colspan="6">KPI Methodology</th></tr>
<tr><th colspan="2">Measurement Calculation Formula</th><th>Measurement Input Source</th><th colspan="2">Measurement Collection Process</th><th>Measurement Collection Frequency</th></tr>
<tr><td colspan="2">Number of ETSI ZSM PoC scenarios approved and presented as a PoC</td><td>ETSI ZSM website</td><td colspan="2">Recording of the PoC and publication to the project's website</td><td>Once when happened</td></tr>
<tr><th colspan="6">Risk Management</th></tr>
<tr><th colspan="3">Identified Risk(s)</th><th colspan="3">Risk Mitigation Plan</th></tr>
<tr><td colspan="3">An ETSI ZSM PoC takes time to be materialized as it requires an official proposal document, a presentation of the proposal, followed by an official approval, a scheduled event to present the PoC, and finally a PoC report.</td><td colspan="3">COP-PILOT planned this activity early on to avoid risking such a PoC towards the end of the project.</td></tr>
</table>

3.7.12 KPI-SDO-12 - ETSI ISG ZSM PoC#4

Table 3-308: KPI-SDO-12 – ETSI ISG ZSM PoC#4.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1 ETSI ZSM PoC#16 Scenario #1 shows how the demonstrated orchestration platform natively provides an integration fabric with security and trust primitives for cross-domain connectivity			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of ETSI ZSM PoC scenarios approved and presented as a PoC		ETSI ZSM website	Recording of the PoC and publication to the project's website		Once when happened
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
An ETSI ZSM PoC takes time to be materialized as it requires an official proposal document, a presentation of the proposal, followed by an official approval, a scheduled event to present the PoC, and finally a PoC report.			COP-PILOT planned this activity early on to avoid risking such a PoC towards the end of the project.		

3.7.13 KPI-SDO-13 - ETSI ISG ZSM PoC#5

Table 3-309: KPI-SDO-13 – ETSI ISG ZSM PoC#5.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	1 ETSI ZSM PoC#16 Scenario #1 shows how the demonstrated orchestration platform exploits the integration fabric demonstrated by KPI-SDO-12 within the same scenario to enable platform expansion to new infrastructure domains in a secure and automated manner			≥1	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of ETSI ZSM PoC scenarios approved and presented as a PoC		ETSI ZSM website	Recording of the PoC and publication to the project's website		Once when happened
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
An ETSI ZSM PoC takes time to be materialized as it requires an official proposal document, a presentation of the proposal, followed by an official approval, a scheduled event to present the PoC, and finally a PoC report.			COP-PILOT planned this activity early on to avoid risking such a PoC towards the end of the project.		

3.7.14 KPI-SDO-14 - Open-source contributions to ETSI HypO

Table 3-310: KPI-SDO-14 – Open-source contributions to ETSI HypO.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	12			≥30	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Number of relevant ETSI HypO open-source contributions made, released, documented, or integrated by UBI or any other COP-PILOT partner in the context of the project. Contributions may include public repositories, merged pull requests, released components, documented integration patterns, deployment artefacts, issues, examples, or COP-PILOT-specific references linked to ETSI HypO.	ETSI OSL GitLab repositories (code, documentation, workflows) COP-PILOT D3.1 [2] and D3.2.	ETSI HypO GitLab boards on ETSI GitLab with acknowledgements to COP-PILOT	Upon every new issue

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Because HypO was proprietary (titled Maestro) until M13, some COP-PILOT contributions cannot "appear" here because they were implemented before the open-source release of ETSI HypO.	N/A

3.7.15 KPI-SDO-15 - Open-source contributions to OpenZiti

Table 3-311: KPI-SDO-15 – Open-source contributions to OpenZiti.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	2	TBD	TBD	≥3	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Number of relevant OpenZiti open-source contributions made, released, documented or integrated by TATA / NetFoundry in the context of COP-PILOT. Contributions may include public repositories, merged pull requests, released components, documented integration patterns, deployment artefacts, issues, examples, or COP-PILOT-specific references linked to OpenZiti.	OpenZiti GitHub repositories; OpenZiti documentation; COP-PILOT D3.1 / D3.2; COP-PILOT SIF deployment and CI/CD repositories; public references to OpenZiti LLM Gateway, OpenZiti MCP Gateway and OpenZiti Agora where applicable.	TATA / NetFoundry will review the relevant OpenZiti and COP-PILOT repositories and record evidence of public contributions, released components, integration references, documentation, issues or pull requests. Evidence will be collected as URLs to repositories, issues, commits, pull requests, documentation pages or COP-PILOT integration artefacts.	At each project evaluation phase: M17, M25 and M33, with final assessment at M36.

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Risk 1: Contributions may be developed or validated internally but not yet visible as public OpenZiti repositories, issues, pull requests or documentation.	Maintain a clear list of public evidence links for every claimed contribution, including repositories, issues, commits, documentation pages or COP-PILOT integration references.
Risk 2: Some COP-PILOT work may consume OpenZiti rather than contribute new reusable open-source assets to the OpenZiti community.	Count only contributions that are reusable beyond COP-PILOT, such as public OpenZiti components, documentation, integration examples, deployment patterns, issues or pull requests.

Risk 3: The OpenZiti AI gateway components may evolve outside the COP-PILOT timeline or may not be fully integrated into COP-PILOT by M33.	Treat LLM Gateway and MCP Gateway as initial measurable contributions and track additional COP-PILOT-specific validation/integration artefacts separately during M25 and M33 evaluation.
Risk 4: Evidence may be fragmented across OpenZiti, NetFoundry and COP-PILOT repositories.	Create a consolidated evidence list for D6.2 / D6.3 / D7 reporting, mapping each OpenZiti contribution to its public URL and COP-PILOT usage context.

3.8 Impact on Communication

3.8.1 KPI-COM-1 - Number of project website visits

Table 3-312: KPI-COM-1 – Number of project website visits.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	26060			>3000	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Matomo analytics		Matomo	Matomo		Last updated on June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.8.2 KPI-COM-2 - Number of entries and readers of web content

Table 3-313: KPI-COM-2 – Number of project's branding views.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
	29 blog posts (see section 2.5.2.3 in Deliverable 7.1 Table 3 [5]) 259 number of unique page views			24 blog posts 250 readers	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**

Number of blogs and unique page views	Partners' websites	Partners' reports	Once in every evaluation phase
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Hard to estimate number of readers given that the blog posts are spread across several website platforms.		The number of unique page views of the blog posts is available as a countermeasure.	

3.8.3 KPI-COM-3 - Number of followers and views on social media

Table 3-314: KPI-COM-3 – Number of followers and views on social media.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	870 followers on LinkedIn 88.330 organic impressions on LinkedIn 3.392 reactions on LinkedIn 30 followers on Mastodon			>250 followers, > 2000 views	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
LinkedIn analytics Mastodon analytics		LinkedIn and Mastodon	LinkedIn analytics Mastodon analytics		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Number of views does not exist as KPI in any social media platform dashboard. There can be impressions, engagement, but nobody can measure views, as nobody knows how many people are in front of the same screen when a post is impressed on a person screen.			Other relevant metrics are extracted, such as organic impressions, reactions, followers.		

3.8.4 KPI-COM-4 - Number of videos and views on YouTube

Table 3-315: KPI-COM-4 – Number of videos and views on YouTube.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	17 videos 1446 views (in total, for the 17 videos)			>5 videos >1000 views	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
YouTube analytics		YouTube	YouTube analytics		Last update on June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.8.5 KPI-COM-5 - Number of presentations and visits in booths

Table 3-316: KPI-COM-5 – Number of presentations and visits in booths.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	24 public presentations (see section 2.6.7 related to Clusters activities). We estimate that the >500 visits target is already achieved			>3 presentations > 500 visits	ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
Sum of all partners presentations in booths	Partners activities	Emails from partners	Last update: June 15th 2026
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
As most of these presentations were presentations in booths at major events, it is impossible to estimate the number of people reached.		N/A	

3.8.6 KPI-COM-6 - Number of contacts by leaflet/flyer distribution

Table 3-317: KPI-COM-6 – Number of contacts by leaflet/flyer distribution.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	> 1000 (estimated) Considering the number of physical public presentations + separate leaflets distributed for the Open Calls (at various events/interactions with other projects), we estimate over 1000 leaflets were distributed to date.			>1500 leaflets distributed >100 new contacts	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Sum of all leaflets distributed by partners		Input from partners	Emails from partners		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

This KPI is hard to compute with high fidelity	N/A

3.8.7 KPI-COM-7 - Number of actions and viewers from interviews and press releases

Table 3-318: KPI-COM-7 – Number of actions and viewers from interviews and press releases.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	3 press releases issued to date 1 interview for HiPEAC magazine (number of readers not available) 1 interview done by JIG at local TV station (number of viewers not available) 36 other articles about COP-PILOT published to date (see D7.1 Section 2.5.2.5 and Table 4 [5])			>8 >1000 viewers	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of press releases Number of articles published Matomo analytics for viewership on COP-PILOT website		As per the left column	As per the left column		Last update: June 15th 2026
Risk Management					
Identified Risk(s) We can only reflect the viewership from COP-PILOT website, as tracked from Matomo. We do not have access to the viewership of magazines/third parties			**Risk Mitigation Plan** **Not applicable**		

3.8.8 KPI-COM-8 - Number of newsletters and recipients by newsletters and mail campaigns

Table 3-319: KPI-COM-8 – Number of newsletters and recipients by newsletters and mail campaigns.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	2			> 4 newsletters > 100 recipients	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
MailerLite analytics LinkedIn analytics		As per the left column	As per the left column		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
NA			NA		

3.9 Impact on Dissemination

3.9.1 KPI-DIS-1 - Number of scientific papers in high-impact topic-specific journals

Table 3-320: KPI-DIS-1 – Number of scientific papers in high-impact topic-specific journals.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	3 published to date 6 more submitted/to be submitted (see D7.1.) Number of readers is not available			>10 >200 readers	NOT ACHIEVED
KPI Methodology					

Measurement Calculation Formula	Measurement Input Source	Measurement Collection Process	Measurement Collection Frequency
Count on the number of papers published	Scientific journals	Counting	Last update: June 15th 2026
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Some of the submitted papers might be rejected by journals. It is not possible to count the number of readers of an article published in a third-party publication, this KPI is not under consortium control		Rework the journal and resubmit. Work with Clusters to identify relevant topics and journals, especially for Cluster 4.	

3.9.2 KPI-DIS-2 - Number of scientific papers in high-impact conferences/workshops

Table 3-321: KPI-DIS-2 – Number of scientific papers in high-impact conferences/workshops.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	10 presented to date 8 more committed under D7.1			>30	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Presentations counting		Zenodo and committed future activities	Counting		Last update on June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Some of the submitted papers might be rejected by journals			Rework the paper and resubmit it to other conferences. Further work with the entire consortium to identify more conferences and submission opportunities, especially with Clusters 2 and 3A.		

3.9.3 KPI-DIS-3 - Number of technical publications/white papers

Table 3-322: KPI-DIS-3 – Number of technical publications/white papers.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	2 published to date 7 other identified and committed under D7.1			>10 > 200 readers	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Counting		Zenodo	Counting		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.9.4 KPI-DIS-4 - Number of participations in symposia and industrial exhibitions

Table 3-323: KPI-DIS-4 – Number of participations in symposia and industrial exhibitions.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result** **ACHIEVED**
0	27 done and 11 more committed under D7.1			>3 > 20 contacts made	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Input from partners		Partners	Emails from partners		Last update: June 15th 2026

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
N/A	N/A

3.9.5 KPI-DIS-5 - Number of liaisons established with other research projects

Table 3-324: KPI-DIS-5 – Number of liaisons established with other research projects.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	7(CEI-Sphere, O-CEI, ICAERUS EU, HEDGE-IoT, TwinEU, and LICORICE. See Deliverables 7.1 and 7.5 for all events done by M18			≥5 liaisons > 5 common events	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Counting of all liaisons and events		Partners	Emails from partners		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.9.6 KPI-DIS-6 - Number of Industry links and future investors interested

Table 3-325: KPI-DIS-6 – Number of Industry links and future investors interested.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result** **ON TRACK**
0	12 industry links			> 25 links > 5 investors interested	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
Links counting	Partners	Counting/Emails from partners	Last update: June 15th 2026
Risk Management			
Identified Risk(s)		**Risk Mitigation Plan**	
Not enough contacts made Not enough investors interested		Further opportunities, particularly at Cluster level.	

3.9.7 KPI-DIS-7 - Number of standardization liaisons and WG/TC members

Table 3-326: KPI-DIS-7 – Number of standardization liaisons and WG/TC members.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	9 working groups with more than 100 participants recorded up to January 2026 (M13)			≥ 3 liaisons >100 WG/TG members	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Relate number of liaisons with the number of SGD WGs Count number of participants across these WGs		SDG WGs	Minutes in SDG WG meetings		Once in every evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.9.8 KPI-DIS-8 - Number of Open Call awareness online workshops

Table 3-327: KPI-DIS-8 – Number of Open Call awareness online workshops.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	4 CEISphere – O-CEI – COP_PILOT: participants D4P 1: 247 participants D4P 2: 228 participants Sploro: > 65 participants			≥4 >100 participants	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Zoom analytics		Zoom analytics	Zoom analytics		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.9.9 KPI-DIS-9 - Number of open online Scientific & Technical workshops and participants

Table 3-328: KPI-DIS-9 – Number of open online Scientific & Technical workshops and participants.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	N/A yet			≥2 > 200 participants	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Participants enrolment		Participants enrolment	Participants enrolment		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.9.10 KPI-DIS-10 - Number of open Strategic Impact workshops and participants

Table 3-329: KPI-DIS-10 – Number of open Strategic Impact workshops and participants.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	N/A yet			≥4 > 400 participants	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Participants enrolment		Participants enrolment	Participants enrolment		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

N/A	N/A

3.9.11 KPI-DIS-11 - Number of showcasing events and participants

Table 3-330: KPI-DIS-11 – Number of showcasing events and participants.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	N/A yet			≥1 > 500 participants	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Participants enrolment		Participants enrolment	Participants enrolment		Last update: June 15th 2026
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.10 Impact on Exploitation

3.10.1 KPI-EXP-1 - Individual exploitable plans

Table 3-331: KPI-EXP-1 - Individual exploitable plans.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	45			≥45 exploitable plans designed	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of individual exploitable plans		D7.2, D7.4	N/A		At M17 and end of project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.10.2 KPI-EXP-2 - Individual exploitable assets

Table 3-332: KPI-EXP-2 - Individual exploitable assets.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	48			≥20 exploitable assets targeted	ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of unique exploitation assets		Exploitable assets repository and D7.2, D7.4	N/A		At M17 and end of project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		

N/A	N/A

3.10.3 KPI-EXP-3 - Technology-driven joint exploitation plans

Table 3-333: KPI-EXP-3 - Technology-driven joint exploitation plans.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
N/A	0			≥3	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of unique technology driven joint exploitation plans		Exploitable assets repository and D7.4 [11]	Questionnaire		At end of project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Limited interest in joint exploitation			Organize workshops to understand challenges, provide consulting on IPRs		

3.10.4 KPI-EXP-4 - Business-driven joint exploitation plans

Table 3-334: KPI-EXP-4 - Business-driven joint exploitation plans.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥6	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of unique business driven joint exploitation plans		Exploitable assets repository and D7.4 [11]	Questionnaire		At end of project

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Limited interest in joint exploitation.	Organize workshops to understand challenges, provide consulting on IPRs

3.10.5 KPI-EXP-5 - Different business models

Table 3-335: KPI-EXP-5 - Different business models.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥2	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of unique business models evaluated		D7.4 [11]	N/A		At end of project
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.10.6 KPI-EXP-6 - Final business and sustainability plans

Table 3-336: KPI-EXP-6 - Final business and sustainability plans.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥1	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of developed sustainability plans		D7.4	N/A		At end of project

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Limited information to perform sustainability analysis	Collect info from clusters early, use alternative sources.

3.11 Impact on Sustainable Development Goals

As explained in Section 2.12, COP-PILOT addresses sustainability impact as a set of long term KPIs at the level of each Cluster.

3.11.1 Cluster 1

For Cluster 1, the M17 sustainability assessment is based on available proxy indicators linked to the Cluster 1 KVIs. Direct sustainability outcomes such as verified CO_2 reductions or measured reductions in fuel consumption cannot yet be validated within the current TRL6 testbed.

For KVI-VSS-CL1-2.7, Reduced fuel emissions from tunnel inspections, KPI-VSS-CL1-2.5 shows progress from manual human inspection visits to manual inspection reporting via Nucleus. This supports the expected sustainability pathway towards fewer vehicle-based inspection activities, but the M17 result is not yet sufficient to quantify avoided travel, fuel savings or emissions reductions.

For KVI-VSS-CL1-2.8, Extended functional lifetime of tracked assets, the M17 results provide early proxy evidence through reduced rock bolt installation time in KPI-VSS-CL1-2.1 and automated positional updates in KPI-VSS-CL1-2.7. These results support the assumption that improved deployment efficiency and better location awareness may reduce asset loss and unnecessary replacement, but the actual sustainability effect requires later validation.

Additional sustainability-relevant proxy evidence comes from KPI-VSS-CL1-2.3, where supported sensor infrastructure increased from 100 to 400 rock bolts, and KPI-VSS-CL1-2.8, where data reception performance increased from 1,000 to 2,500 packets per second. These results indicate improved technical capacity for broader monitoring coverage, which may support more efficient inspections and resource use in later stages.

For KVI-VSS-CL1-4.5, Reduced cloud dependency and transmission overhead, KPI-VSS-CL1-4.5 shows autoscaling demonstrated in a simulation environment. This provides early support for the expected sustainability logic of more efficient workload placement and reduced unnecessary data movement, but no quantified reduction in energy use, cloud dependency or transmission overhead can yet be concluded at M17.

Overall, the M17 sustainability assessment provides early proxy evidence for potential reductions in manual inspection activity, improved asset utilisation and more efficient edge-to-cloud resource use. The assessment will be complemented during later evaluation cycles with more mature automatic inspection functionality, additional measurements, stakeholder feedback, and where relevant modelled estimates of avoided travel, reduced data transfer and resource utilisation effects.

3.11.2 Cluster 2

3.11.2.1 KPI-SDG-CL2-1 - Productivity & Validation Performance

Table 3-337: KPI-SDG-CL2-1 - Productivity & Validation Performance.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	75%			100%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
(Number of installed devices operating correctly without hardware or network faults / Total number of installed devices) * 100.		Physical deployment inventory and automated hardware health-check diagnostics (heartbeats) from the platform dashboard.	Cross-referencing the official physical installation list against the real-time active telemetry logs to identify unresponsive, physically damaged, or malfunctioning nodes.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Hardware malfunction due to harsh environmental conditions affecting the physical integrity of outdoor sensors.			Use industrial enclosures for all outdoor hardware.		

3.11.2.2 KPI-SDG-CL2-2 - Market Readiness & Commercial Viability

Table 3-338: KPI-SDG-CL2-2 - Market Readiness & Commercial Viability.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0%	50%			100%	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Number of VSA KPIs with an 'Achieved' status / Total number of evaluated KPIs * 100.		KPI tracking matrix and individual technical evaluation reports	Systematic audit of all individual VSA KPIs at the end of the evaluation cycle. The final status of each KPI is verified, and the successful metrics are aggregated to compute the overall operational success index.		At each evaluation phase.
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Unforeseen integration bottlenecks preventing the prototype from operating reliably in the real-world environment (stalling the project at TRL 5 or 6)			Conducting iterative, phased pilot testing to resolve integration issues early		

3.11.3 Cluster 3A

3.11.3.1 KPI-SDG-CL3A-1 - Sustainable & Low-Impact Leafy Vegetable Production

Table 3-339: KPI-SDG-CL3A-1 - Sustainable & Low-Impact Leafy Vegetable Production.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	N/A			≥1	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of documented SDG contributions: number of CL3A pilot outcomes formally mapped to SDG 2, 12, 13, or 15 targets		Measured results from KPI-VSS-CL3A-1, KPI-VSS-CL3A-3, and KPI-VSS-CL3A-5; KVI-VSS-CL3A-5 environmental footprint evidence	AgroApps maps measured input reductions (pesticide, herbicide, water) and logistics CO_2 results to the corresponding SDG targets		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
mall pilot scale may limit the magnitude of measurable environmental contributions			Contributions documented in both physical units and percentage reductions vs. baseline		

3.11.3.2 KPI-SDG-CL3A-2 - Digital Inclusion & Decent Work in Contract Farming

Table 3-340: KPI-SDG-CL3A-2 - Digital Inclusion & Decent Work in Contract Farming.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	N/A			≥1	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of documented SDG contributions: number of CL3A pilot outcomes formally mapped to SDG 8 (Decent Work and Economic Growth) or SDG 10 (Reduced Inequalities) targets		KPI-SOC-CL3A-2 labour hour results; KVI-VSS-CL3A-1 input cost saving results; AgroApps 360 usage logs; BAR farmer training and onboarding records	AgroApps maps measured labour hour reductions, per-hectare cost savings, and the number of contract farmers actively and independently using COP-PILOT-enhanced precision agriculture tools to the corresponding SDG targets.		At each evaluation phase
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
Partial farmer adoption limits documentable contributions.			BAR agronomist support programme and farmer training drive adoption.		

3.11.4 Cluster 3E

3.11.4.1 KPI-SDG-CL3E-1 - Accelerating Renewable Energy Integration and Grid Decarbonisation

Table 3-341: KPI-SDG-CL3E-1 - Accelerating Renewable Energy Integration and Grid Decarbonisation.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0	0			≥1	NOT ACHIEVED
KPI Methodology					
Measurement Calculation Formula		**Measurement Input Source**	**Measurement Collection Process**		**Measurement Collection Frequency**
Count of documented SDG contributions: number of CL3E pilot outcomes that can be formally mapped to SDG 7, 9, or 13 targets		Energy production/consumption logs grid flexibility reports	Mapping measured energy and environmental results		At final evaluation
Risk Management					
Identified Risk(s)			**Risk Mitigation Plan**		
N/A			N/A		

3.11.5 Cluster 4

3.11.5.1 KPI-SDG-CL4-1 - Circular and Trustworthy IoT for Sustainable Vineyard Operations

Table 3-342: KPI-SDG-CL4-1 - Circular and Trustworthy IoT for Sustainable Vineyard Operations.

KPI across project evaluation phases					
Baseline Value (M1)	**Measured Value – Initial Evaluation (M17)**	**Measured Value – Intermediate Evaluation (M25)**	**Measured Value – Final Evaluation (M33)**	**Target Value (M36)**	**Assessment Result**
0, no circular IoT lifecycle process in place; no euID wallet-based traceability for sensor reuse/recycling	Use case model, recycling platform concept, and wallet concept defined; operational validation pending.			Demonstrated circular IoT workflow contributing to ≥80% sensor recovery, measurable e-waste reduction, and wallet-based lifecycle traceability for pilot sensors.	NOT ACHIEVED

KPI Methodology			
Measurement Calculation Formula	**Measurement Input Source**	**Measurement Collection Process**	**Measurement Collection Frequency**
SDG contribution assessed through combined evidence from sensor recovery rate, waste reduction percentage, lifecycle traceability completeness, and GDPR/data sovereignty compliance	RedZinc recycling platform; euID wallet records; pilot logs; recycling/reuse confirmation records; compliance review evidence	Collect and review evidence from each pilot lifecycle workflow, including sensor deployment, monitoring, maintenance, reuse, recycling and wallet updates.	At each evaluation phase and after each recovery/recycling workflow

Risk Management	
Identified Risk(s)	**Risk Mitigation Plan**
Limited real end-of-life sensor events during pilot; difficulty quantifying SDG contribution from small pilot scale	Use controlled test batches, simulated lifecycle events where required, and qualitative SDG evidence supported by platform logs and wallet records.

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