AI REDGIO 5.0 Experiment Plan - M12

D6.1

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Abbreviations and Acronyms:	
AI	Artificial Intelligence
EXP	Experiment
DF	Didactic Factory
DoE	Document of Experiment
ML	Machine Learning
SME	Small and Medium Enterprises
DIH	Digital Innovation Hub
EDIH	European Digital Innovation Hub
EU	European Union
ICT	Information Communication Technologies
PLC	Programmable Logical Computer
KPI	Key Performance Indicator
MVP	Minimum Viable Product
IIOT	Industrial internet of things
IoT	Internet of Things
OEE	Overall Equipment Effectiveness
TERESA	Technical and Regulatory Sandbox
TEF	TERESA Experiment Factories
WISE	Well-being, Inclusion, Sustainability and Equal Opportunity
HW	HardWare
SW	SoftWare
QA	Quality Assurance

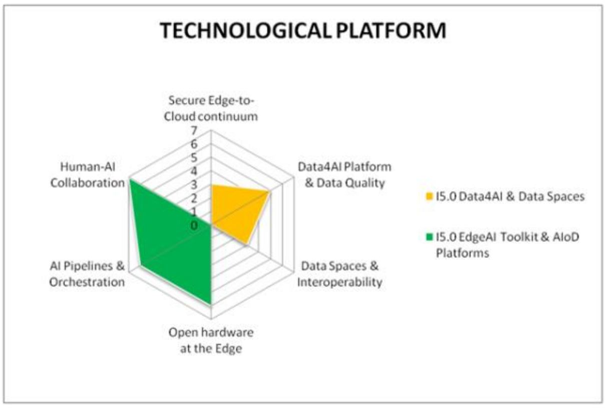
Executive summary

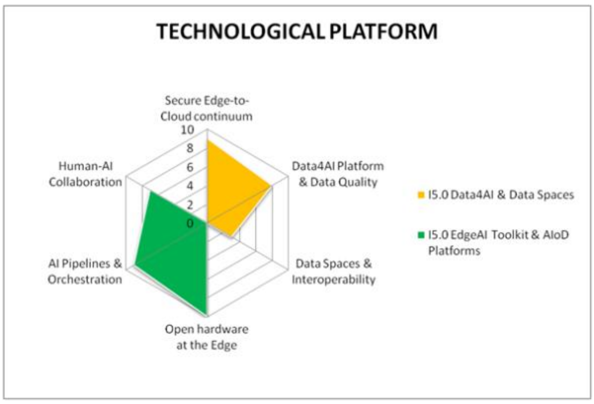
The **goal of AI REDGIO 5.0** project is to **move artificial intelligence (AI) and machine learning (ML) to the "edge"** which means closer to the source of manufacturing information. This "local cloud" depicts the possibility to have an efficient computing infrastructure locally, which can be of a big importance for manufacturing small and medium-sized enterprises (SMEs). AI REDGIO 5.0 is lowering the complexity and cost barriers for manufacturing enterprises (notably SMEs) to develop, deploy and fully leverage the cloud/edge computing paradigm for the implementation of applications like predictive maintenance, quality management, Zero Defect Manufacturing, Lifecycle Assessment, Intelligent Asset Management, Human Robot Collaboration and Digital Twins, through providing:

- **free open source**, and **user-friendly tools** for developing end-to-end **pipeline for edge ML/AI applications**;
- **cloud/edge AI deployment patterns and blueprints for different manufacturing applications.**

During the project implementation **7 SMEs** are monitored and supported in their experiments' deployment and **14 Didactic Factories** around Europe are involved for the implementation of didactic experiments addressed to SMEs. Each experiment presented in this document is detailed in terms of concept, timeline planning, milestones, deliverables and expect results. All of them will have 2 iterations. First iteration will cover initial development tasks and testing in controlled conditions. A second iteration will include a refinement of the initial achieved results and will consider lessons learned in the first iteration.

For a better understanding of the document a recap of the technological platforms used by SME-driven experiments and Didactic Factories is shown here below. For more details please refer to deliverable D2.2





SME-driven experiments are on the left, while DFs experiments are on the right

This deliverable is structured as follows: Chapter 1 presents the methodology applied to monitor the experiments, Chapter 2 illustrates the implementation plan and the expected results for each experiment, Chapter 3 presents some conclusions and the next steps to be taken in subsequent activities developed in WP 6.

1. Methodology

The WP6 is linked to all the project WPs as it can be seen in Figure 1. It acts as a bridge among the methodology WP – WP2, the (E)DIHs – WP3, the technical WPs – WP4, 5, 7 and the experiments.

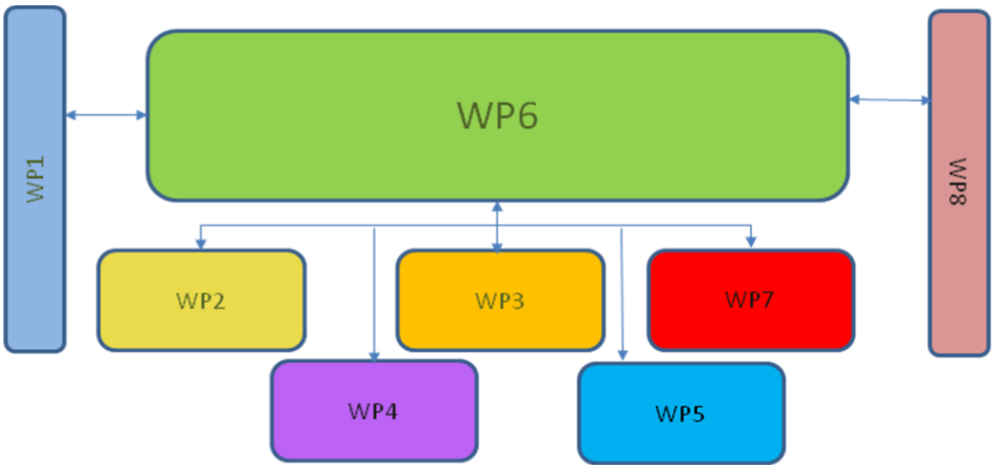


Figure 1 WP6 diagram

In WP2 some tools for the monitoring of the project have been developed, which are presented in D2.1 AI REDGIO 5.0 Requirements Engineering Methodology, and in particular the Trial Handbook, which is used in WP6 as a monitoring and assessment tool for the experiments. A schematic representation of the above-mentioned elements is reported in Figure 2. In this sense, the main elements used to follow-up on the development of the experiments and associated with the activities in this work package are related to the 1st and 2nd iterations to start testing and verifying their results as well as to adjust their activities according to the lessons learned encountered in the process. Key outputs are expected to be extracted from the 1st iteration according to the detailed plans proposed by the SME-driven and Didactic Factories experiments.

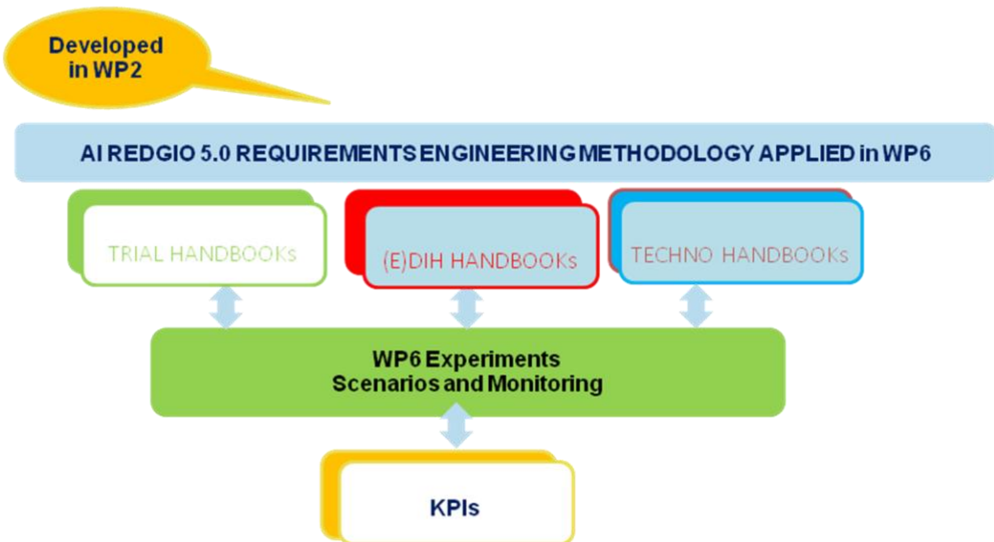


Figure 2 Tools for the monitoring of the project

Within WP6, T6.1 is focused on high level coordination of the experiments and coordination of the other tasks, while T6.2 – SME driven AIREGIO experiments-, T6.3- SME driven AI PILOT regions, and T6.4 – TERESA experiments - concentrate on the deployment of experiments and their monitoring.

Finally, T6.5 is devoted to the implementation of the Open Call experiments.

In T6.1 the alignment of the experiments is assured by monthly meetings among the Task leaders and plenary meetings among all the experiments every 3 months. These meetings are also a good occasion to share results achieved and problems met with the other project WPs and among the experiments themselves.

In T6.2, T6.3 and T6.4 a deeper monitoring and support of the experiments is provided through bi-monthly meetings. During these meetings the experiments can show the progress made and present their needs to the technical WPs and to the (E)DIHs.

2. Experiments Plan

2.1. AI REDGIO 5.0 SME-driven experiments

AI REDGIO 5.0 fosters the implementation of 7 SME-driven experiments, 3 belonging to AI REGIO regions – Lombardy (IT), Rhōne Alps (FR) and Slovenia (SI) - and 4 to AI PILOT regions – Galicia (ES), Trentino (IT), Wales (UK) and North East Romania (RO), as listed in the Table 1.

Table 1 List of SME driven experiments

N°	Experiment name	Organization	Region
Pilot I	Real time monitoring for control & detection of production	SCAMM	Lombardy
Pilot II	AI and DTwins for agility in mould making	PERNOUD	Rhōne Alps
Pilot III	AI-enabled Digital Twins for Virtual Commissioning	QUESCREM	Galicia
Pilot IV	AI-based autonomous machine for safer faster agriculture	GPALMEC	Trentino
Pilot V	Intelligent Contextualized Visual System for error reduction	CAP ENGINEERING	Wales
Pilot VI	Quality Assurance of clothing production	KATTY	North East Romania
Pilot VII	Predictive maintenance and zero-defect production of moulds	POLYCOM	Slovenia

In the following chapters, the concept and implementation plan of each experiment is presented. For some experiments the plan for the second iteration, which will start at month 22, is also presented. This has to be considered as a draft that will be refined and presented in deliverable D6.5, available in month 24.

2.1.1. SME PILOT I SCAMM (LOMBARDY, ITALY): AI-BASED QUALITY CONTROL OF WHITE GOODS COMPONENTS

SME PILOT I Concept

SCAMM in an Italian company born in 1975; since then, it operates in the industrial automation for cold metal sheet transformation process sector. Its technical knowledge in prefabrication and assembling technologies and continuous research allows the company to be a worldwide leader, offering an integrated service able of dealing with any specific automation requirement in appliances. The sector of operation is manufacturing of special equipment for automatic sheet metal forming and assembling, mainly for major home and professional appliances.

In the frame of AIREDGIO 5.0, SCAMM leads an experiment dealing with the real time monitoring for control and detection of production non-conformances in a reconfigurable pressing line. The aim of this experiment is the development of a physical model of the line that can predict variations in the quality of the final product starting from the process parameters. For this purpose, there will be used real-time monitoring and predictive AI algorithms which allow to optimize both efficiency and product quality.

SME PILOT I Plan

The experiment deals with an integrated solution for sheet metal working automation (forming, cutting, drawing, etc.) that allows to manufacture complex finished products such as large household appliances.

The planned activities - Table 2, the milestones - Table 3, the deliverables – Table 4 and the expected results – Table 5 - are shown below.

Table 2 List of planned activities - SCAMM

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 –Experiment management																																				
T2 – Requirements Analysis																																				
T3 – Hardware dev. And implementation of monitoring system																																				
T4 – Data collection from IT system																																				
T5 – Implementation of AI model																																				
T 6 – Development of AI support tool																																				
T 7 – Testing in control laboratory condition																																				
T8 – Validation in the industrial context)																																				
T9 – Dissemination, communication and exploitation																																				

Table 3 List of milestones - SCAMM

N°	Milestone name	Date (month)
1	Architecture and monitoring system definition	M15
2	Validation in the laboratory-controlled conditions	M30
3	Validation in the industrial environment	M35

Table 4 List of deliverables - SCAMM

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date(month)
1	Monitoring system and architecture definition	PORINI	Report	Confidential	M15
2	Report on the AI support tools	IMECH	Report	Confidential	M30
3	Validation results and lessons learned	IMECH	Report	Confidential	M36
4	Demonstrative video	IMECH	Video	Public	M36

Table 5 Expected results - SCAMM

N°	Result description	Date (month)
1	Historicization of process parameters that are currently not monitored or available only from the PLC.	M15
2	Automatization of the quality control process for a specific product and historicization of quality data (synthetic index and images): improvement of the prototype developed during the DIGITbrain EU program.	M18

For a better understanding, in the following list a detailed description of each activity is reported:

Experiment 1st iteration

- *Task 1 - Experiment concept finalization*
    - Task 1.1: Definition of the experiment main goals.
    - Task 1.2: Definition of the experiment team and provider support.
- *Task 2 - Requirements Analysis*
    - Task 2.1: Technical and functional requirements definition (1).
    - Task 2.1: Definition of the technical and functional requirements.
    - Task 2.1: Definition of human requirements (interface and interaction).
- *Task 3 - Implementation of the ICT architecture and monitoring system (1)*
    - Task 3.1: ICT architecture definition.
    - Task 3.2: ICT architecture implementation.
    - Task 3.3: Implementation of monitoring system.
- *Task 4 -Data collection from IT system (1)*
    - Task 4.1: Data collection.
    - Task 4.2: Data validation.
- *Task 5 Implementation of AI model*
    - Task 5.1: Implementation of AI model for quality control.
    - Task 5.2: Implementation of AI model for process parameters and product quality correlation.

- *Task 6 - Development of AI support tool*
  - Task 6.1: Implementation of a dashboard for KPIs monitoring, anomaly detection, and trend analysis.
  - Task 6.2: Implementation of a dashboard for knowledge management.
- *Task 7 - Testing in controlled laboratory conditions*
  - Task 7.1: Verification and validation of the developed tools with historical data.
  - Task 7.2: Testing with real operators to evaluate the tool usability.

Experiment 2nd iteration

The second iteration will constitute a refinement to take in consideration the lessons learned in the first iteration following the test in controlled conditions.

- *Task2 - Technical and functional requirements definition (2)*
- *Task 3 - Implementation of the ICT architecture and monitoring system (2)*
  - Task 3.2 Implementation of the ICT architecture and monitoring system (2).
- *Task 4 - Data collection from IT system (2)*
  - Task4.2 - Data collection from IT system (2).
- *Task 8 - Validation in the industrial environment*
  - Task 8.1: Verification and validation of the developed tools in the industrial environment with real-time data.
- *Task 9 - Dissemination, communication, and exploitation*
  - Task 9.1: Dissemination and communication of the project results within our local and international network.; One-to-one interviews with interested companies to evaluate future applications of the developed tool.

2.1.2. SME PILOT II PERNOUD (RHÔNE ALPS, FRANCE): DECISION-MAKING TOOL FOR THE REALIZATION AND ORGANIZATION OF THE MANUFACTURING SEQUENCES IN A SHOP FLOOR

SME PILOT II Concept

Pernoud specializes in creating, modifying, and repairing complex moulds, each comprising hundreds of pieces. Each piece undergoes more than ten specific operations in a particular order for manufacturing. The traditional approach involves manually planning the manufacturing sequence for each piece in the ERP system, causing delays and inefficiencies.

As part of the AIREDGIO 5.0 initiative, artificial intelligence (AI) will serve as a decision-making tool for organizing manufacturing sequences in a shared shop floor with various business units. This AI will connect with the PERNOUD MES system to assess the current status of tasks and predict potential delays or advancements.

SME PILOT II Plan

AIREDGIO 5.0 incorporates AI into Pernoud's operations to streamline the manufacturing sequence planning process, providing real-time insights, alerts, and advice to optimize efficiency, with users maintaining control over the final decisions.

The planned activities – Table 6, the milestones – Table 7, the deliverables – Table 8 and the expected results – Table 9 - are shown below.

Table 6 List of planned activities – Pernoud

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Experiment concept finalization																																				
Technical and functional requirements definition (1)																																				
Data collection from IT system (1)																																				
Implementation of AI model																																				
Development of AI module																																				
AI module setting up																																				
Training																																				
Technical and functional requirements definition (2)																																				
Implementation of live time monitoring																																				
Data collection from IT system (2)																																				
Validation in the industrial environment																																				
Dissemination, communication, and exploitation																																				

Table 7 List of milestones - Pernoud

N°	Milestone name	Date (month)
1	Technical and functional requirements definition	M12
2	1st demo ready	M18
3	AI Tool set up	M30
4	AI Tool validate in the Pernoud organization	M36

Table 8 List of deliverables - Pernoud

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date(month)
1	Technical and functional requirements definition	PERNOUD	Report	Confidential	M12
2	1st iteration demonstrator	PERNOUD	Demo	Confidential	M18
3	Result and lessons learned of the first iteration	PERNOUD	Report	Confidential	M19
4	Validation results and lessons learned	PERNOUD	Report	Confidential	M36

Table 9 Expected results - Pernoud

N°	Result description	Date (month)
1	New planning tool, with numeric dashboard	M18
2	Automatization of manufacturing sequences realization	M18
3	Implementation of the planning module	M27
4	Implementation of the manufacturing sequences module	M27
5	Module tested and working in Pernoud organization	M36

For a better understanding, in the following list a detailed description of each activity is reported:

Experiment 1st iteration

- *Task 1 - Experiment concept finalization*
  - Task 1.1 - Definition of the experiment main goals.
  - Task 1.2 - Definition of the experiment team and provider support.
- *Task 2 - Technical and functional requirements definition*
  - Task 2.1 - Definition of the technical and functional requirements; Definition of human requirements (interface and interaction).
- *Task 3 - Data collection from IT system*
  - Task 3.1 - Data collection.
  - Task 3.2 - Data validation.
- *Task 4 - Implementation of AI model*
  - Task 4.1 - Implementation of AI model for manufacturing sequences.
  - Task 4.2 - Implementation of AI model for planning activities.
- *Task 5 - Development of AI module*
  - Task 5.1 - Implementation of a dashboard for manufacturing sequences management.
  - Task 5.2 - Implementation of a dashboard for planning management.

- *Task 6 - AI module setting up*
  - Task 6.1 - Verification and validation of the developed tools with historical data.
  - Task 6.2 - Testing with operators to evaluate the tool ergonomic.
- *Task 7 - Training: Training activities to help PERNOUD employees for working with those new technologies*

Experiment 2nd iteration

- *Task 2 - Technical and functional requirements definition*
  - Task 2.2 - the second iteration will be focused on the integration of the live time monitoring of the machines and will take into account the lessons learn in the first iteration.
- *Task 8 - Implementation of live time monitoring*
  - Task 8.1 - ICT system definition
  - Task 8.2 - ICT system implementation
- *Task 4 - Data collection from IT system. The second iteration will be focused on the integration of the live time monitoring of the machines and will take into account the lessons learn in the first iteration.*
- *Task 9 - Validation in the industrial environment*
  - Task 9.1 - Verification and validation of the developed tools in PERNOUD organization
- *Task 10 - Dissemination, communication, and exploitation*

2.1.3. SME PILOT III QUESCREM (GALICIA, SPAIN): QUALITY IMPROVEMENT OF CHEESE PRODUCTS AND REDUCTION OF WASTES

SME PILOT III Concept

QUESCREM is an Innovative Spanish Dairy Company specialized in developing, manufacturing and commercializing different varieties of Cream Cheese, Mascarpone and other Customized Products. Quescrem aims to enhance the quality of their cheese cream while simultaneously reducing waste to promote sustainability. The company prioritizes delivering top-notch products with consistent organoleptic properties, focusing on factors like creaminess. Quescrem is committed to achieving the highest product quality and minimizing variability in organoleptic properties. Simultaneously, the company strives to align with sustainability objectives by minimizing waste generation and optimizing the use of raw materials, water, and energy in manufacturing processes.

SME PILOT III Plan

The project proposes leveraging process data from Quescrem's MES and real-time data from production lines. The goal is to prescribe optimal parameters that not only minimize waste, primarily permeate, but also enhance product quality, such as achieving a uniform cream cheese texture, and improve overall manufacturing efficiency. The planned activities – Table 10, the milestones – Table 11, the deliverables – Table 12 and the expected results – Table 13 - are shown below.

Table 10 List of planned activities – Quescrem

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Exploratory Data Analysis																																				
T2 - State of the art exploration regarding AI-Edge models																																				
T3 - Initial DoE																																				
T4 – 1st version implementation of ETL process																																				
T5 - 1st version implementation of AI-Edge models																																				
T6 - 1st version implementation of optimization module																																				
T7 - 1st implementation of orchestration Framework																																				
T8 - First integration and validation of experiment																																				
T9 - Refinement of the experiment's initial design																																				
T10- 2nd version implementation of ETL process																																				
T11 - 2nd version implementation of AI-Edge models																																				
T12 - 2nd version implementation of optimization module																																				
T13 - 2nd version implementation of orchestration Framework																																				
T14 - Final integration and validation of experiment																																				

Table 11 List of milestones - Quescrem

N°	Milestone name	Date (month)
1	First design of experiment	M9
2	First version implementation of all experiment's components	M18
3	Deployment and validation of the first version implementation	M21
4	Final design of experiment	M23
5	Second version implementation of all experiment's components	M36
6	Deployment and validation of the final implementation	M36

Table 12 List of deliverables - Quescrem

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date(month)
1	First design of experiment	Quescrem & Gradiant	Doc	Confidential	M9
2	First version implementation of all experiment's components	Quescrem & Gradiant	Doc/SW	Confidential	M18
3	Deployment and validation of the first version implementation	Quescrem & Gradiant	Doc	Confidential	M21
4	Final design of experiment	Quescrem & Gradiant	Doc	Confidential	M23
5	Second version implementation of all experiment's components	Quescrem & Gradiant	Doc/SW	Confidential	M36
6	Deployment and validation of the final implementation	Quescrem & Gradiant	Doc	Confidential	M36

Table 13 Expected results - Quescrem

N°	Result description	Date (month)
1	Definition of the requirements and scope of the experiment	M6
2	Exploration of the state of the art regarding Incremental Learning based AI-Edge models and optimization and prescription algorithms.	M6
3	Initial design of the experiment's architecture	M9
4	First version implementation of the forecasting module	M18
5	First version implementation of the optimization and prescription module	M18
6	First version implementation of the orchestration framework	M18
7	Deployment and validation of the first version of all the experiment's components	M21
8	Final design of the experiment's architecture	M23
9	Second version implementation of the forecasting module	M36
10	Second version implementation of the optimization and prescription module	M36
11	Second version implementation of the orchestration framework	M36
12	Deployment and validation of the final version of all the experiment's components	M36

For a better understanding, in the following list a detailed description of each activity is reported:

Experiment 1st iteration

- *Task 1 - Exploratory Data Analysis*: preliminary collection and analysis of all data sources available from the experiment's production process.

- *Task 2 - State of the art exploration regarding AI-Edge models*: exploration of the state of the art regarding Incremental Learning based AI-Edge models and optimization and prescription algorithms.
- *Task 3 - Initial DoE*: in detailed both functional and technical design of the experiment's architecture, including: Extract-Transform-Load required processes from the collection and preprocessing of data from production lines; edge computing AI models for real-time forecasting of production KPIs; cloud-based production optimization service from the edge-computing AI model's outputs; Framework for the orchestration of all experiment's components; integration of experiment's architecture with AIREDGIO5.0 platform.
- *Task 4 - 1st version implementation of ETL process*: technical development of the first version of the required ETL process, based on the previous analysis and experiment's design.
- *Task 5 - 1st version implementation of AI-Edge models*: technical development of the first version of Edge-computing AI models for production quality forecasting, based on the previous analysis and experiment's design.
- *Task 6 - 1st version implementation of optimization module*: technical development of the first version of the cloud-based service for optimization of production quality, based on the previous analysis and experiment's design.
- *Task 7 - 1st version implementation of orchestration Framework*: technical development of the first version of the orchestration framework for AI models within the IT infrastructure, based on the previous analysis and experiment's design.
- *Task 8 - 1st integration and validation of experiment*: Integration, deployment and testing of the first version of the experiment's components in order to validate, both functionally and technically, the whole solution.

Experiment 2nd iteration

- *Task 9 - Refinement of the experiment's initial design*: Refinement of the initial functional and technical design of the experiment's architecture, including all the components considered in the first version. It will be based on the lessons learned from the first iteration.
- *Task 10 - Second version implementation of ETL process*: Technical development of the second version of the required ETL process, refining and complementing the first version implementation. The lessons learned from the first iteration of the experiment will be applied and additional features might be implemented in order to provide the final implementation of this module.
- *Task 11 - Second version implementation of AI-Edge models*: Technical development of the second version of Edge-computing AI models for production quality forecasting, refining and complementing the first version implementation. The lessons learned from the first iteration of the experiment will be applied in order to provide the final implementation of this module.
- *Task 12 - Second version implementation of optimization module*: Technical development of the second version of the cloud-based service for optimization of production quality, refining and complementing the first version implementation. The lessons learned from the

first iteration of the experiment will be applied and additional features might be implemented in order to provide the final implementation of this module.

- *Task 13 - Second version implementation of orchestration Framework*: Technical development of the second version of the orchestration framework for AI models within the IT infrastructure, refining and complementing the first version implementation. The lessons learned from the first iteration of the experiment will be applied and a more advanced orchestration framework is expected to be implemented in order to provide the final implementation of this module.

- *Task 14 - Final integration and validation of experiment*: Integration, deployment and testing of the second version of the experiment's components in order to validate, both functionally and technically, the whole final solution.

2.1.4. SME PILOT IV GPALMEC (TRENTINO, ITALY): AUTONOMOUS DRIVING FOR AGRICULTURAL VEHICLE

SME PILOT IV Concept

The project aims to make agricultural machines autonomous to enhance the safety of human operators. This is particularly crucial in high-risk environments, such as steep agricultural lands with narrow tree rows, where manual operation can be dangerous and even fatal due to the risk of rollovers, severe impacts, and loss of control. The motivation for this critical aspect is the risk of vehicle rollover, severe impact and loose of control. According to the ANSA press release – June, 10^{th} 2022 – from 2010 and 2020 there have been more than 2.000 fatal accident involving tractors only in Italy.

This project focuses on retrofitting an existing agricultural machine made by a SME (based in Trentino-Alto Adige). GPALMEC, the technological partner and automation system manufacturer, develops a plug-in system to make the machine autonomous. In order to facilitate the implementation of the new functionalities, it will be installed an additional PLC (interface PLC) that will take care of the autonomous drive and will communicate with the PLC that drives the machine (master PLC). The interface PLC will collect all the information from the sensors, run the analyses and gives the master PLC the commands to move the machine. To transfer the commands to the master PLC and to retrieve from it the machine status, it will be set up a data exchange between the two PLCs.

The machine will be equipped with sensors that allows the correct positioning of the tractor within the working area, the recognition of the rows of trees to follow and the obstacles to avoid. AI at the edge is performed by the integrated sensors' electronics and by the interface PLC.

SME PILOT IV Plan

In summary, the project aims to enhance agricultural machine safety by transforming an existing machine into an autonomous one, specifically addressing challenges in high-risk environments.

The planned activities – Table 14, the milestones – Table 15, the deliverables – Table 16 and the expected results – Table 17 - are shown below.

Table 14 List of planned activities – GPALMEC

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - GPALMEC – FBK agreement																																				
T2 - Hardware selection																																				
T3 - Machine control unit communication																																				
T4 - Camera, sensors and modem test and communication																																				
T5 - Machinery directive study and application																																				
T6 - Driving help logic test – 1^{st} iteration																																				
T7 – Result analysis and driving help implementation in OEM machine																																				
T8 – OEM machine test in agricultural field – 2^{nd} iteration																																				
T9 - Communication and Dissemination																																				

Table 15 List of milestones – GPALMEC

N°	Milestone name	Date (month)
1	GPALMEC – FBK agreement	M1
2	Hardware selection	M6
3	OEM machine communication	M18
4	Hardware test and procurement	M18
5	Machinery directive study	M18
6	Driving help logic test	M18
7	Driving help implementation in OEM machine	M21
8	OEM machine test	M36

Table 16 List of deliverables – GPALMEC

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Handbook chapters 1 and 2	GPALMEC	Report	Restricted	M6
2	Handbook chapter 3	GPALMEC	Report	Restricted	M11
3	Component list	GPALMEC - FBK		Restricted	M6
4	OEM machine data exchange	GPALMEC - GEIER		Restricted	M18

Table 17 Expected results – GPALMEC

N°	Result description	Date (month)
R1	Prototype of driving help system	18
R2	Implementation of driving help system into OEM machine	34

For a better understanding, in the following list a detailed description of each activity is reported:

- *Task 1 - GPALMEC & FBK agreement*: definition and distribution of the project tasks.
- *Task 2 - Hardware selection*: a selection of the needed hardware has been made considering the requirements needed by mobile applications, i.e. low/high temperature and high humidity insensibility and fed with low voltage.
- *Task 3 - Machine control unit communication*: definition of specifications for data exchange between interface PLC for driving help and OEM machine control unit in order the machine to be driven by the added PLC.
- *Task 4 - Camera, sensors and modem tests and communication*: equipment test and communication set up for PLC data acquisition.
- *Task 5 - Machinery directive study and application*: the machinery directive is studied and applied in order the final product to be compliant with European requirements.
- *Task 6 - Driving help logic test – 1st iteration*: the equipment is assembled and tested in GPALMEC facility. The test is run without OEM machine to evaluate the driving help logic.
- *Task 7 - Result analysis and driving help implementation in OEM machine*: the set-up is adjusted according to the T6 result. The equipment is then implemented in the OEM machine.

- *Task 8 - OEM machine test – 2nd iteration*: the OEM machine equipped with driving help equipment is tested on real agricultural field.
- *Task 9 - Communication and Dissemination of the experiment and its outcomes.*

Results explanation:

- *Result 1 - Prototype of driving logic*: the prototype of the driving help system is scheduled for M18. The system will be composed by the selected hardware, each device will perform its specific task and the communication between interface PLC and sensors and between interface PLC and OEM machine logic will be working.
- *Result 2 - Implementation of driving help system into OEM machine*: the driving help system is implemented into OEM machine.

2.1.5. SME PILOT V CAP (WALES, UK): INTELLIGENT CONTEXTUALISED VISUAL SYSTEM FOR ERROR REDUCTION

SME PILOT V Concept

CAP Engineering Services Ltd is a SME machine builder and Systems Integrator, specializing in intelligent automation equipment. One of the CAP's products is an aerospace fastener, a crucial component utilized in cutting-edge composite aircraft fuselages. This component is made of three distinct parts and it can be crafted from either aluminium, titanium, or stainless steel.

Presently, a skilled operator manually assembles the components, securing them in a nest fixture within a lathe chuck. Subsequently, the assembly undergoes swaging to establish a secure connection between the outer components, encapsulating the center. This manual process demands about 30 to 40 seconds per part, with the outcome heavily reliant on the operator's expertise. Moreover, given the manual nature of the assembly, there's a susceptibility to errors, necessitating a thorough manual inspection of each component before progressing to the next.

SME PILOT V Plan

Recognizing the drawbacks of the current process, the project team is actively developing an innovative AI-driven automation solution for quality management. The goal is to expedite the process, enhance quality control, and promptly address defects during production.

The planned activities – Table 18, the milestones – Table 19, the deliverables – Table 20 and the expected results – Table 21 - are shown below.

Table 18 List of planned activities – CAP

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Wales Smart Lab specification						■																														
T2 - Prototype Development							■	■	■	■																										
T3 - Final build & Commissioning											■	■	■	■	■	■	■	■	■	■																
T4 – User Testing and Feedback																					■															

Table 19 List of milestones – CAP

N°	Milestone name	Date (month)
1	Define MVP (Swaged Aerospace Fastener – 3 parts)	M6
2	Functional Spec / Tech spec	M6
3	Define KPIs	M6
4	Hardware Selection & Procurement	M10
5	Develop Swaging machine and AI Vision Components	M10
6	Define operations, assembly tasks and AI integration	M10
7	Testing of automatic and manual functionality	M20
8	Functional demonstration	M20
9	External SME engagement	M21

Table 20 List of deliverables – CAP

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Experiment overview	CAP	R	Confidential	M6
2	Business requirements	CAP	R	Confidential	M9
3	Implementation and results at M21	CAP	R	Confidential	M21

Table 21 Expected results - CAP

N°	Result description	Date (month)
1	POC Prototype completed for testing	M20
2	Final System deployment	M21

For a better understanding, in the following list a detailed description of each activity is reported:

- *Task 1* - Overview of current situation and existing data sources (M6)
- Task 2 - Preparation of specifications and development of prototype machine and vision system testing
- *Task 3* - Final build of automated swaging machine and AI model for automated quality inspection
- *Task 4* - Development of first prototype solution to be tested at M21, testing onsite for user feedback

2.1.6. SME PILOT VII KATTY FASHION (ROMANIA): DEVELOPMENT OF A PRODUCT DEFECT DETECTION SYSTEM FOR CLOTHING ITEMS

SME PILOT VI Concept

KATTY FASHION is a bespoke women wear services company offering product design, development and manufacturing. The aim of the experiment is the development of a product defect detection system with the following functionalities: acquire product images; manipulate images by an embedded AI tool; extract information about the nature and severity of the product defect; send alerts to the QA personnel in charge of the product check. The developed system should be able to assist the QA team in validating the correctness of the operations done for the analyzed item based on close integration with the initial design characteristics.

SME PILOT VI Plan

The main objective of the experiment is to offer a technical alternative, through automation, to the manual operation of evaluating the quality of the products made by KATTY FASHION.

The planned activities – Table 22, the milestones – Table 23, the deliverables – Table 24 and the expected results – Table 25 - are shown below.

Table 22 List of planned activities – KATTY FASHION

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Scenario Analysis Establishment of the Hardware and Software architecture	X	X	X	X	X	X	X	X	X	X	X	X																								
T2 - Business/Technological Requirements, elicitation and analysis.								X	X	X	X	X	X	X	X	X	X	X																		
T3 - Technical Requirement Specification and AI-focused architecture design							X	X	X	X	X	X	X	X	X	X	X	X																		
T4 – Deployment and verification (second iteration)									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
T5 - Requirement validation, assessment and lessons learned.									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 23 List of milestones – KATTY FASHION

N°	Milestone name	Date (month)
1	Preliminary classification of defects	M6
2	Algorithm for clothes defects detection	M15
3	First System architecture validation	M18
4	Testing and validation of the Py-QUAD-AI@E prototype	M36

Table 24 List of deliverables – KATTY FASHION

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Define system and architecture definition)	KF&TUI	Report	Confidential	M3
2	Report on the Algorithm for defect detection	KF&TUI	Report	Confidential	M15
3	Functional demonstration	KF&TUI	Report	Confidential	M18
4	Define operations, assembly tasks and AI integration	KF&TUI	Report	Confidential	M24
5	Testing of automatic and manual functionality	KF&TUI	Report	Confidential	M34
6	Testing and validation of the Py-QUAD-AI@E prototype	KF&TUI	Report	Confidential	M36

Table 25 Expected results – KATTY FASHION

N°	Result description	Date (month)
1	1ST version of Functional demonstration of the detection system for clothing items	M18
2	Final deployment of the defect detection system for clothing items	M36

For a better understanding, in the following list a detailed description of each activity is reported:***Experiment 1st iteration***

- *Task 1 - Scenario Analysis Establishment of the Hardware and Software architecture*
    - *Task 1.1* - Concept definition.
    - *Task 1.2* - Drawing of as-is scenarios.
    - *Task 1.3* - Assessment /Observation of technical problems (due to complexity of the quality process check performed by a human operator) analysis of technical solutions.
    - *Task 1.4* - Analysis of several types of clothing, made at KF, with the identification of reported defects.
    - *Task 1.5* - Classifying several types of clothing, made at KF, with the identification of reported defects.
    - *Task 1.6* - Organization of Brainstorming sessions// meetings in order to identify technical solutions.
    - *Task 1.7* - Drawing of to-be scenarios.
    - *Task 1.8* - Hardware, Software architecture proposal.
    - *Task 1.9* - Scenario validation.
- *Task 2 - Business/Technological Requirements, elicitation and analysis*
    - *Task 2.1* - Business process modeling.
    - *Task 2.2* - Business requirements identification.
    - *Task 2.3* - Technological requirements identification.
    - *Task 2.4* - Prioritization of experiment requirements.

- *Task 2.5* - Experiment requirements validation.

- *Task 3 - Technical Requirement Specification and AI-focused architecture design*
  - *Task 3.1* - Identification of technical requirements of system components. (first iteration).
  - *Task 3.2* - AI-focused architecture design (first iteration).
  - *Task 3.3* - System architecture validation (first iteration).

Experiment 2nd iteration

- *Task 4 - Deployment and verification (second iteration)*
  - *Task 4.1* - Development of the EM-QUAD-AI@E experimental model (HW equipment development; Mechanical HW Electronic HW; Integration of mechanical HW + electronic HW; SW platform development) (second iteration).
  - *Task 4.2* - Development of AI algorithms dedicated to the detection of defects in finished clothing products; development of simulation functions in the MATLAB simulation environment development of firmware models for edge-computing AI device.
  - *Task 4.3* - Integration of the electronic module of the experimental model EM-QUAD-AI@E HW + SW integration of the EM-QUAD-AI@E experimental model.
  - *Task 4.4* - Testing and validation of the EM-QUAD-AI@E experimental model.
  - Task 4.5 - Development of the Py-QUAD-AI@E prototype; HW equipment development; SW platform development; HW + SW integration of Py-QUAD-AI@E prototype.
  - *Task 4.6* - Testing and validation of the Py-QUAD-AI@E prototype.

- *Task 5 - Requirement validation, assessment and lessons learned*
  - *Task 5.1* - Creation of a database of defects in clothes. TUIASI will provide KF with equipment for capturing images and storing them in a database.
  - *Task 5.2* - KF will assign an operator to capture the images, identify the defects in the finished clothing products through the images and save the images in the local database.
  - *Task 5.3* - TUIASI will use the database to train the AI learning process so that it can automatically identify defects in (finished clothing products), when analyzing new images, in the QA process.
  - *Task 5.4* - Assessment of coverage and completion of experiment requirements.
  - *Task 5.5* - Lessons learned/dissemination of results.

2.1.7. SME PILOT IV POLYCOM (SLOVENIA): MAXIMIZATION OF AVAILABILITY, PRODUCTION QUALITY AND EFFICIENCY OF MOLDING MACHINES

SME PILOT VII Concept

The experiment aims to validate and demonstrate the adoption of the smart production monitoring solution for injection moulding processes. The main objective of the experiment is to overview the already achievable data sources in the production and to identify the means how these data can be employed to improve the insight into production process. The main interest of the data analysis will be oriented towards providing the predictive maintenance solutions that will be able to scale over larger set of moulding machines that the company owns, and to obtain more detailed and faster insight into the current state of the process equipment and moulding tool as it is available at the moment.

With the analysis of the data and implementation of the AI powered tools it is expected that the following benefits could be addressed:

- Decrease unplanned stoppages.
- Improve stability of products' quality.
- Increase operational life-time of the production equipment.
- Transfer of the concept to other machines in the company.
- First step towards company-wide approach for predictive maintenance.

SME PILOT VII Plan

The planned activities – Table 26, the milestones – Table 27, the deliverables – Table 28, and the expected results – Table 29 - are shown below.

Table 26 List of planned activities – POLYCOM

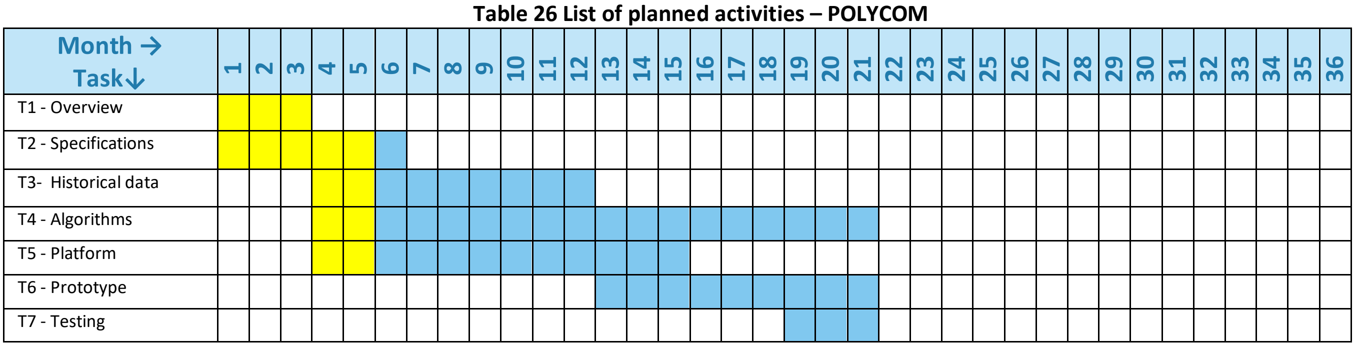


Table 27 List of milestones – POLYCOM

N°	Milestone name	Date (month)
1	Platform and algorithms ready for first version implementation	M15
2	First iteration of the solution tested and validated	M21

Table 28 List of deliverables - POLYCOM

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Experiment overview	POLYCOM	R	Confidential	M6
2	Business requirements	POLYCOM	R	Confidential	M9
3	Implementation and results at M21	POLYCOM	R	Confidential	M21

Table 29 Expected results - POLYCOM

N°	Result description	Date (month)
1	First iteration of edge platform	M15
2	First iteration of moulding process monitoring algorithms	M18

Hereafter the tasks' description is reported:

- *Task 1 - Overview*
  - Overview of current situation and existing data sources.
- *Task 2 - Specifications*
  - Preparation of specifications and scenario definition.
- *Task 3 - Historical data*
  - Initial overview of historical data samples and identification of other potentially relevant process data to be captured.
- *Task 4 - Algorithms*
  - Overview of possible analytical approaches to be used, development of the algorithms.
- *Task 5 - Platform*
  - Overview of Arrowhead platform, small scale example preparation, exploration of existing infrastructure and identification of upgrade needs and integration approach.
- *Task 6 - Prototype*
  - Development of first prototype solution to be tested at M21.
- *Task 7 - Testing*
  - Testing and validation of the first prototype solution using historical process data and obtaining operators' feedback.

2.2. Didactic Factories experiments

The DF experiments are 14 as listed in the Table 30.

Table 30 List of DF experiments

N°	Experiment name	DF Name	Region
DFI	Industry4.0Lab	POLIMI - I4.0LAB	Lombardy
DFII	E2Mech	UNIBO – ACTEMA	Emilia-Romagna
DFIII	Self-evolving monitoring system for assembly production lines	JSI - IJS SYSTEMS & CONTROL LAB	Slovenia
DFIV	Flexible Manufacturing – Vision Enhancement through Synthetic Data	BRAINPORT INDUSTRIES -	Nederland
DFV	IIoT SmartBox	UNITWENTE – AMC	Nederland
DFVI	4.0 iLab FBK	FBK - 4.0ILAB	Trentino
DFVII	Predictive Maintenance 5.0	MAKE - PM50	Flanders
DFVIII	Digital Manufacturing Innovation Hub	DMWI - DIGITAL INNOVATION MANUFACTURING INNOVATION HUB	Wales
DFIX	BEhAI – Adapting quality inspection system to human behavior and human states	MADE	Lombardy
DFX	Implementation of QAD-AI@E solution in the real clothing manufacturing environment	TUIASI I4.0	Romania
DFXI	AI-driven Monitoring of Robotic Assembly Process	CTU RICAIP	Czech Republic
DFXII	AAU Advanced IoT	AAU SMART LAB	Denmark
DFXIII	SunSync: AI solution for optimizing recycling in industry at the level of am-LAB's DF	PBN amLAB	Hungary
DFIV	Galicia DF	GRADIANT - GALICIA INDUSTRIAL LOGISTICS LAB	Spain

In the following chapters, the concept and implementation plan of each experiment is presented. For some experiments the plan for the second iteration, which will start at month 22, is also presented. This has to be considered as a draft that will be refined and presented in deliverable D6.5, available in month 24.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Health and Digital Executive Agency (HaDEA). Neither the European Union nor HaDEA can be held responsible for them.

2.2.1. POLIMI - I4.0LAB (LOMBARDY, ITALY): INDUSTRY4.0LAB

DF Concept

Industry4.0lab is a Didactic Factory (DF) part of Politecnico di Milano (POLIMI), whose aim is to train MSc Engineering students through hands-on activities which traditional study curricula usually lack. The facility hosts indeed a manufacturing line devoted to the assembly of small electronic devices, accompanied by isolated robotic assets which accomplish material handling activities and/or are devoted to cooperate with humans in the tasks devoted to end-of-life of electronic devices. In the frame of AIREDGIO 5.0, the INDUSTRY4.0LAB experiment at improving the efficiency of a HRI task in executing highly flexible activities.

DF Plan

The experiment targets a handling-oriented clustering of shapes derived by an image processing. After this clustering a data-driven (and properly trained) algorithm for the selection of the most effective combination of cobots and end effectors is supposed to be implemented. The expected results comprise:

- improved efficiency for electronic boards handling (decrease of crack and of drops during manipulation
- diminished setup time.
- diminished variance due to specific worker's expertise
- increase of multidisciplinary skills trained to thesis student

Below, detailed information is reported about the planned activities – Table 31, the milestones – Table 32, and the expected results – Table 33.

Table 31 List of planned activities: POLIMI - I4.0LAB

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Data collection campaign																																				
T2 - Data manipulation																																				
T3 - Data conversion																																				
T4 - AI Tool selection																																				
T5 - Data Augmentation																																				
T6 – 1st iteration of AI model training																																				
T7 - AI model fine tuning (1)																																				
T8 - AI model evaluation (1)																																				
T9 - Test- bed setup (1)																																				
T10 - Design of User-Friendly Interface and Tools for AI																																				
T11 - Incorporating TERESA elements																																				
T12 – 1st Iteration of the experiment																																				
T13 - 1st iteration experiment report																																				
T14 - Analysis of the results from the 1st iteration of the experiment																																				
T15 - PCB components detection AI model error analysis																																				
T16 - Designing Orchestrator																																				

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T17 - Integrate the Orchestrator with Robotic System																								X	X	X	X	X	X	X						
T18 - AI model fine tuning (2)																												X	X	X						
T19 - AI model evaluation (2)																														X	X	X				
T20 - Test- bed setup (2)																																X	X	X	X	X
T21 - Re-assessing TERESA specific elements																																X	X	X	X	
T22 – 2nd iteration experiment report																																			X	X

Table 32 List of milestones: POLIMI - I4.0LAB

N°	Milestone name	Date (month)
1	Collect an initial diverse dataset of PCB images with annotated bounding boxes around components	M06
2	Achieve a satisfactory level of accuracy on the validation set	M12
3	Deploy the trained model for PCB component detection	M12
4	Train operators on the user interface of the AI application.	M16
5	Introduce to the operators the ergonomic principles relevant to the use of the AI system.	M10
6	Validation of Iteration 1 (including WISE implications and TERESA aspects).	M18
7	Provide training on handling errors, such as cases where the model might make incorrect predictions.	M24
8	Instruct operators on how to recognize degradation in model performance and when retraining may be necessary.	M28
9	Validation of Iteration 2 (including WISE implications and TERESA aspects)	M36

Table 33 Expected results: POLIMI - I4.0LAB

N°	Result description	Date (month)
1	Implementation of AI models to facilitate desoldering of Printed Circuit Boards performed by human by detecting the components which are needed to be removed from PCB to reduce setup time.	M12
2	AI-on-the-edge Didactic Factory (DF) Iteration 1, tested in real-like environment in laboratory, and integrating AI models (from N°1), camera, point clouds, images, PCBs, co-bot and the end-effector. WISE implications and TERESA aspects are covered in this DF.	M18
3	Implementation of AI models dedicated to ensuring selection of proper configuration for performing of the task by human using AI object detector as well as an orchestrator to choose proper end-effector from available tools to reduce handling errors.	M30
4	AI-on-the-edge Didactic Factory (DF) Iteration 2, tested in real-like environment in laboratory, and integrating AI models (from N°3), orchestrator, camera, point clouds, images, PCBs, co-bot and the end-effector. WISE implications and TERESA aspects are covered in this DF.	M36

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 - Data collection campaign*: Capturing several images taken from PCBs to be used as input of AI model.

- *Task 2 - Data manipulation*: Labeling images using collected image set.
- *Task 3 - Data conversion*: Organizing the input images in JSON format specifying locations of interests for PCB components.
- *Task 4 - AI Tool selection:* Benchmarking among the several AI algorithms in order to choose the best applicable for the use case.
- *Task 5 - Data Augmentation*: Artificially increasing the training set by creating modified copies of a dataset using existing data.
- *Task 6 - 1st iteration of AI model training*: First trial to train the AI model using training data set.
- *Task 7 - AI model fine tuning (1)*: Monitor the training process and fine-tune hyperparameters such as learning rate, batch size, and others as needed.
- *Task 8 - AI model evaluation (1):* Evaluate the trained model on a separate test set to assess its performance.
- *Task 9 - Test*- bed setup (1): Preparing the set of equipment required for testing the AI model.
- *Task 10 - Design of User-Friendly Interface and Tools for AI*: Incorporate tools and features that reduce cognitive load and make the interaction with the AI model smoother including WISE implications.
- *Task 11 - Incorporating TERESA elements*: Before the implementation of the experiment in lab environment the TERESA aspects as well as WISE implications will be elaborated.
- *Task 12 - 1st Iteration of the experiment*: First iteration of the experiment will be implemented by application of AI model to detect bounding boxes of Printed Circuit Boards components of the interest to facilitate the human task considering WISE implications.
- *Task 13 - 1st iteration experiment report:* The obtained results taken from the first iteration of the experiment considering TERESA elements and WISE implications will be reported.
- *Task 14 - Analysis of the results from the 1st iteration of the experiment:* Identifications of the weaknesses and gaps of the performed experiment.
- *Task 15 - PCB components detection AI model error analysis*: Conduct an in-depth analysis of errors made by the model. Understand the patterns and reasons behind.
- *Task 16 - Designing Orchestrator*: Developing an orchestrator to help operator in selection of the proper end effectors among the pool of available tools based on the type of the PCB component of interest.
- *Task 17 - Integrate the Orchestrator with Robotic System*: Ensure seamless integration with the robotic system. The orchestrator should communicate with the robotic control system and provide instructions on end effectors selection.
- *Task 18 - AI model fine tuning (2):* Fine-tune hyperparameters based on the insights gained from the initial training.
- *Task 19 - AI model evaluation (2):* Re-assess the composition of the validation set, ensuring it is representative of the overall dataset and includes challenging examples.

- *Task 20 - Test- bed setup (2):* Preparing the set of equipment required for testing the AI model and the Orchestrator.
- *Task 21 - Re-assessing TERESA specific elements:* Prior to testing the 2nd Iteration of the Experiment in-the-field, the TERESA aspects are re-assessed:
    - involve Competent Authority in assessing 1st Iteration (with regard to WISE implications and TERESA aspects) and setting up the tests and demonstrations of the 2nd Iteration;
    - recruiting and engaging volunteers (focus on SMEs) for demonstrating and testing the 2nd Iteration.
- *Task 22 - 2nd iteration experiment report.*

2.2.2. UNIBO – ACTEMA (EMILA-ROMAGNA, ITALY): E^{2}MECH

DF Concept

ACTEMA is the DF managed and operated by the ACTEMA research group of DEI (Department of Electrical, Electronic and Information Engineering "Guglielmo Marconi") of the University of Bologna. The DF develops methods and technologies in the fields of:

- advanced control of mechatronic systems, power electronic systems and industrial automation plants;
- condition monitoring, diagnostics and prognostics of plants and machines;
- design and development of innovative embedded control, actuation and monitoring platforms, oriented to edge computing.

The proposed experiment is placed in the context of automatic machines, in particular that of servomechanisms (mechatronic chains). This is motivated by the growing interest in the development of techniques and methodologies aimed at making the aforementioned systems "smart", with particular attention to minimizing the economic effort for maintenance and energy consumption of the same.

DF Plan

E^{2}Mech is aimed to:

- to develop and propose an edge-computing platform for reliable time-consistent data gathering, elaboration and interfacing with cloud-computing systems;
- possibly, including power units to drive motors and smart actuators;
- to develop and propose algorithms mixing AI methods, physics modelling and automatic control techniques for:
    - CMP of standard servomechanisms advanced control and CMP of innovative servomechanisms, leading to more sustainable mechatronics;
    - to develop and propose tools and procedures to help the overall development process.

The planned activities – Table 34, the milestones – Table 35, the deliverables – Table 36, and the expected results – Table 37 - are shown below.

Table 34 List of planned activities: UNIBO - ACTEMA

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Experiment and KPI definition																																				
T2 - Methods																																				
T3- Platform																																				
T4 – 1st iteration: data acquisition																																				
T5 – 1st iteration: solution application and deployment																																				
T6 – 1st iteration: solution assessment																																				
T7 – 2nd iteration: data acquisition																																				
T8 – 2nd iteration: solution application and deployment																																				
T9 – 2nd iteration: solution assessment																																				

Table 35 List of milestones: UNIBO - ACTEMA

N°	Milestone name	Date (month)
1	1st Iteration: Dataset from a E2 Mech real prototype	M19
2	1st Iteration: Mixed Physics-driven and data-driven control/diagnostic-oriented models and algorithms applied to a E2 Mech real system	M21
3	2nd Iteration: Additional Dataset from a E^2 Mech real system	M36
4	2nd Iteration: Models and algorithms tuning and refinement	M36

Table 36 List of deliverables: UNIBO - ACTEMA

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date(month)
1	1st Iteration: Process and Monitoring Dataset	UNIBO	Data	Confidential	M18
2	1st Iteration: E^2 Mech acquisition system preliminary prototype	UNIBO	Prototype	Confidential	M21
3	1st Iteration: Solution assessment (considering ergonomics and working conditions improvement, and TERESA aspects)	UNIBO	Report	Confidential	M21
4	2nd Iteration: Additional Process and Monitoring Dataset	UNIBO	Data	Confidential	M33
5	2nd Iteration: E^2 Mech acquisition system prototype improvement and refinement	UNIBO	Prototype	Confidential	M36
6	2nd Iteration: Solution assessment (considering ergonomics and working conditions improvement, and TERESA aspects) improvement and refinement	UNIBO	Report	Confidential	M36

Table 37 Expected results: UNIBO - ACTEMA

N°	Result description	Date (month)
1	1st Iteration: On-board functionality that enables proper data acquisition and transmission for possible updating of operating algorithms, along the whole lifetime of the system. Proper system usability: condition indices to represent the system behaviour to non-skilled operators.	M21
2	1st Iteration: Lower the motion tracking error of mechanisms, i.e. improve the trajectory tracking accuracy of the mechanism by making the overall tracking error lower than a percentage of the considered trajectory range (max error: 0.5%)	M21
3	2nd Iteration: improvements and refinements of system usability and data acquisition and transmission infrastructure obtained in the 1stIteration.	M36
4	2nd Iteration: anomaly detection with sensitivity better than 10% deviation w.r.t nominal conditions.	M36

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 - Experiment and KPI definition*

- Selection of the servomechanisms to be considered in the E2Mech experiment and KPI definition (valid in general for advanced control and diagnostics of mechatronic systems).

- *Task 2 - Methods*
    - Simulation and synthetic data generation.
    - Mixed Physics-driven and data-driven control/diagnostic-oriented models.
    - Definition and modelling of meaningful anomalies.
    - Definition of design procedures and algorithms for advanced control and diagnosis/monitoring.
- *Task 3 - Platform*
    - Development/adaptations of proprietary platforms, based on Single core Cortex M4 and Tri-core 2xCortex A7 and 1xCortex M4 for edge-computing oriented to control/diagnosis/monitoring.
    - Investigation of alternative PLC-based platforms.
    - Data acquisition pipeline development for training, inference and continual learning.
- *Task 4 - 1st iteration: data acquisition*
    - Acquisition of data from the considered E^{2}Mech setup, by exploiting the current platform, for 1st iteration testing and validation.
- *Task 5 - 1st iteration: solution application and deployment*
    - Application of current methods, deployed on the current platform, to the considered E^{2}Mech setup, for 1st iteration testing and validation.
- *Task 6 - 1st iteration: solution assessment*
    - As specified in the last WISE point (Ergonomics and improving working conditions), working conditions improvement assessed by volunteers (as specified in TERESA experiments' relevant aspects).
- *Task 7 - 2nd iteration: data acquisition*
    - Improvements and refinements of the 1st iteration.
- *Task 8 - 2nd iteration: solution application and deployment*
    - Improvements and refinements of the 1st iteration.
- *Task 9 - 2nd iteration: solution assessment*
    - Improvements and refinements of the 1st iteration, keeping into account WISE and TERESA aspects.

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2.2.3. JSI - IJS SYSTEMS & CONTROL LAB (SLOVENIA) E2-LAB: SELF-EVOLVING MONITORING SYSTEMS FOR ASSEMBLY PRODUCTION LINES

Concept

Jozef Stefan Institute (JSI) is the leading scientific research and development organization in Slovenia covering a broader spectrum of disciplines: physics, chemistry, electronics, automation and information technologies, nuclear reactor engineering and energetic. The experiment "Self-evolving monitoring systems for assembly production lines" consists of an industrial set-up representing a part of the DC drive assembly process. The experiment will set up a test bed for self-evolving solutions for monitoring production asset performances, targeting repetitive processes, such as assembly production lines. Demonstrated diagnostic systems diagnostic system that will self-learn by analysing the sequences of patterns from fault-free process operation process time-series measurement, while using machine-learning methods.

Plan

The Experiment aims to:

- develop a test bed for self-evolving solutions for monitoring the production asset performance while targeting the repetitive processes such as assembly production lines;
- develop an affordable platform that could be scaled to other processes;
- implement additional sensor to the existing experimental setup;
- explore and progress the development of self-evolving monitoring algorithms;
- perform didactic exploitation of the data and platform (involvement of students in development and testing of new solutions).

The planned activities – Table 38, the milestones – Table 39, the deliverables – Table 40, and the expected results – Table 41 - are shown below.

Table 38 List of planned activities: JSI – IJS Systems&Control

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Specifications																																				
T2 - Initial platform preparation (1st iteration)																																				
T3 - Algorithms (1st iteration)																																				
T4 - Implementation and testing, consideration of WISE implications (1st iteration)																																				
T5 - Didactic activities (1st iteration)																																				
T6 - WISE implication monitoring (1st iteration)																																				
T7 - Platform upgrade (2nd iteration)																																				
T8- Algorithms upgrade (2nd iteration)																																				
T9 - Didactic activities (2nd iteration)																																				
T10 - Final validation and exploitation (2nd iteration)																																				
T11 - WISE implications monitoring (2nd iteration)																																				

Table 39 List of milestones: JSI – IJS Systems&Control

N°	Milestone name	Date (month)
1	First data available from initial platform for didactic exploitation and development of algorithms.	M10
2	First iteration of the solution tested and validated, including WISE implications.	M21
3	Stable solution of platform and algorithms implemented.	M33
4	Final validation performed, including WISE implications.	M36

Table 40 List of deliverables: JSI – IJS Systems&Control

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Experiment overview.	JSI	Report	Confidential	M6
2	Business requirements.	JSI	Report	Confidential	M9
3	Implementation and results (D6.4).	JSI	Report	Confidential	M18
4	Description of the system and algorithms implemented.	JSI	Report	Confidential	M36

Table 41 Expected results: JSI – IJS Systems&Control

N°	Result description	Date (month)
1	Students' work results prepared and evaluated on real production data.	M17
2	First iteration of algorithms for monitoring assembly production lines and WISE implications.	M21
3	Selected students' work results prepared integrated in experimental environment.	M33
4	Platform for Self-Evolving Monitoring Systems for Assembly Production Lines.	M36

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 - Specifications*
    - Preparation of specifications and scenario definition.
- *Task 2 - Initial platform preparation (1st iteration)*
    - Integration of additional sensors to the existing process (energy, pressure sensors), preparation of initial platform capturing initial representative data.
- *Task 3 - Algorithms (1st iteration)*
    - Overview of possible analytical approaches to be used, development of the algorithms.
- *Task 4 - Implementation and testing, consideration of WISE implications (1st iteration)*
    - Integration of the prepared platform in production process, implementation of first version of algorithms, testing and evaluation, preparation of specifications for next iteration (updated version).

- *Task 5 - Didactic activities (1st iteration)*
    - Didactic exploitation of the setup through involvement of students (preparation of material, workshop, project work).
- *Task 6 - WISE implication monitoring (1st iteration)*
    - Monitoring of the activities considering the WISE implications, focusing on human factors and privacy factors. Selection of the competent authority.
- *Task 7 - Platform upgrade (2nd iteration)*
    - Upgrade of the platform to enable long term monitoring of the algorithms and improvement of user interfaces.
- *Task 8 - Algorithms upgrade (2nd iteration)*
    - Real-time implementation of the perspective algorithms resulting from the didactic activities.
- *Task 9 - Didactic activities (2nd iteration)*
    - Another round of didactic activities involving the students to develop new algorithms for self-evolving monitoring of assembly production lines.
- *Task 10 - Final validation and exploitation (2nd iteration)*
    - Final validation of the platform and exploitation activities (preparation of open datasets, scientific dissemination).
- *Task 11 - WISE implications monitoring (2nd iteration)*
    - Monitoring of the activities considering the WISE implications, focusing on human factors and privacy factors. Communication with the competent authority.

2.2.4. UNITWENTE – AMC (NEDERLAND): IIOT SMART BOX

DF Concept

AMC is an industrial shop floor whose aim is to offer innovative services to strengthen the (manufacturing) industry in the region and beyond. In the framework of AI REDGIO 5.0, the main objective of this experiment is to help SMEs to implement **IoT architecture** and relevant AI applications with the low-cost, easy expansion, flexible customization and low-effort deployment. The architecture and tools components presented in this experiment are designed to address the obstacles and challenges for implement digitalization in SMEs.

DF Plan

The main objective of this experiment is to help DF and SMEs to implement IIoT architecture and relevant AI applications with the low-cost, easy expand, flexible customization and low-effort deployment. The architecture and tools components presented in this experiment are designed to address the obstacles and challenges mentioned above for implement digitalization for manufacturing. The experiment is aimed to:

- Developing a lightweight IIoT architecture and software platform.
- Real-time production monitoring by collecting sensor data based on proposed IIoT architecture.
- Developing AI algorithms at the edge for production process analysis, quality control, maintenance, etc.
- Developing AI algorithms at the edge for predictable OEE and reduce the energy consumption and increase productivity, etc.

The planned activities – Table 42, the milestones – Table 43, the deliverables – Table 44, and the expected results – Table 45 - are shown below.

Table 42 List of planned activities: UniTwente - AMC

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Application scenarios and requirements analysis																																				
T2 - Software and hardware architecture design																																				
T3- System architecture development and preliminary testing																																				
T4 - Use case application development (1st iteration)																																				
T5 - Experimental verification and evaluation (1st iteration)																																				
T6 - Experimental improvements and summary (2nd iteration)																																				
T7 - Experimental verification and evaluation(2st iteration)																																				

Table 43 List of milestones: UniTwente - AMC

N°	Milestone name	Date (month)
1	System architecture developed completed	M12
2	Algorithm development and evaluation (1st iteration)	M18
3	Algorithm and final overall applications and scenarios (2st iteration)	M30
4	System evaluation and results (2st iteration)	M36

Table 44 List of deliverables: UniTwente - AMC

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Experiment introduction document	UTW&SME	Document	Confidential	M12
2	System architecture design document	UTW&SME	Document	Confidential	M14
3	Algorithm and application technical documentation at 1st iteration (Include TERESA aspect and WISE implication)	UTW&SME	Document	Confidential	M18
4	Algorithm and application technical documentation at 2st iteration (Include TERESA aspect and WISE implication)	UTW&SME	Document	Confidential	M30
5	Experiment results and evaluation reports	UTW&SME	Document	Confidential	M36

Table 45 Expected results: UniTwente - AMC

N°	Result description	Date (month)
1	IIoT smart-box system architecture and basic functions e.g. data collection and data storage and data visualization, etc.	M12
2	Implement AI edge-side algorithms to process data. Through sensor data processed by AI algorithms, applications such as intelligent real-time monitoring, quality classification at 1st iteration (Include TERESA aspect and WISE implication).	M18
3	Improved algorithm and scenario design based on evaluation. Integrate further data and applications at 2st iteration (Include TERESA aspect and WISE implication).	M30
4	Practical application to industrial production and evaluation KPI for IIoT smart box and make corresponding improvements.	M36

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 - Application scenarios and requirements analysis*
  - Design system application scenarios and conduct demand analysis under different application scenarios.
- *Task 2 - Software and hardware architecture design*
  - Overall architecture design, selection of hardware platform and design of software modules.

- *Task 3 - System architecture development and preliminary testing*
  - Development of the hardware and software platform. The software platform modules include sensor data acquisition, data transmission, data storage, and data visualization.
- *Task 4 - Use case application development (1st iteration)*
  - Implement specific algorithms for use cases and applications. Including AI algorithms applying for sensor data (temperature, vibration, sound, etc.), and implement specific applications such as real-time monitoring, quality classification, etc. The TERESA aspect in terms of EU regulations and ethical principles and the WISE will also be considered.
- *Task 5 - Experimental verification and evaluation (1st iteration)*
  - The system will be tested and evaluated at DF; moreover, the WISE implication will also be included.
- *Task 6 - Experimental improvements and summary (2nd iteration)*
  - Improve designs and algorithms based on results from testing and evaluation. Add more types of data (such as image data) and corresponding applications and algorithms based on 1st iteration results. The TERESA aspect and the WISE will also be included for proof of solution.
- *Task 7 - Experimental verification and evaluation (2st iteration)*
  - The entire system undergoes final evaluation and improvements; moreover, the WISE implication will also be included.

2.2.5. FBK - 4.0ILAB (TRENTINO, ITALY): 4.0ILAB

DF Concept

I4.0Lab Didactic Factory at FBK (Trentino, Italy) is a facility created to support tech transfer activities (co-design, prototyping, and technological integration of 3rd-party solutions) of IoT sensing applications, cognitive techniques, and advanced ICT solutions for the control of connected machines and plants and monitoring of industrial environments. The FBK 4.0iLab is functional for realizing prototypes in the context of IoT and AI-based industrial applications.

DF Plan

The experiment aims to transition AI-based methodologies and techniques from the cloud to the network's edge, facilitating improved efficiency and effectiveness in industrial applications such as:

- **Predictive Maintenance:** proactive equipment maintenance, reducing downtime and costs, and providing data-driven insights for optimized schedules.
- **Parts Traceability:** Real-time tracking, quality assurance, efficient recall management, and counterfeit detection, enhancing supply chain visibility and customer trust.
- **Quality Control:** Automatic defect detection, optimizes processes, and enables continuous monitoring, leading to improved product quality and manufacturing efficiency.

The planned activities – Table 46, the milestones – Table 47, the deliverables – Table 48, and the expected results – Table 49 - are shown below.

Table 46 List of planned activities: FBK - 4.0iLAB

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1.1 - Project initiation																																				
T1.2 - Research and requirements gathering																																				
T1.3- Evaluation framework development																																				
T1.4 - Elaborating WISE and TERESA specific elements (1st iteration)																																				
T1.5 - Scenario 1 development																																				
T2.1 - Feedback Analysis																																				
T2.2 - Elaborating WISE and TERESA specific elements (2nd iteration)																																				
T2.3 - Scenario 2 development																																				
T2.3 - Final reports																																				

Table 47 List of milestones: FBK - 4.0iLAB

N°	Milestone name	Date (month)
1	Evaluation framework implementation.	M12
2	First scenario architecture description and improvements including WISE implications and TERESA factors.	M18
3	Second scenario architecture description and improvements including WISE implications and TERESA factors.	M30

Table 48 List of deliverables: FBK - 4.0iLAB

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Evaluation Framework definition	TBD	Report	Confidential	M12
2	Scenario 1 evaluation	TBD	Report	Confidential	M18
3	Framework updates	TBD	Report	Confidential	M24
4	Scenario 2 evaluation	TBD	Report	Confidential	M30

Table 49 Expected results: FBK - 4.0iLAB

N°	Result description	Date (month)
1	Define a framework to evaluate EdgeAi applications.	M18
2	Identify a set of significant evaluation scenarios for a distributed application taking into account WISE implications and TERESA factors.	M24
3	Improve the application architecture.	M35

- For a better understanding, in the following list a detailed description of each task is reported:***Task 1 – First iteration***
    - *Task 1.1 - Project initiation*
        - Define project objectives, scope, and success criteria.
    - *Task 1.2 - Research and requirements gathering*
        - Conduct a thorough analysis of edge AI architectures in business applications. Define technical requirements for the platform. Research existing solutions and technologies in the field.
    - *Task 1.3 - Evaluation framework development*
        - Develop the architectural design of the platform (both hardware and software components). Implement the first a prototype of the platform for initial testing and feedback.
    - *Task 1.4 - Elaborating WISE and TERESA specific elements (1st iteration)*
        - Before the development of scenario 1, WISE and TERESA specific elements will be assessed focusing on human factors, privacy and data and confidentiality issues.
    - *Task 1.5 - Scenario 1 development*
        - Identify the business application. Evaluate and provide feedback to improve the edge Ai architecture.

- ***Task 2 – Second iteration***
  - *Task 2.1 - Feedback Analysis*
    - Evaluate the results of first scenario. Implements corrections and potential new requirements to the evaluation platform.
  - *Task 2.1 - Elaborating WISE and TERESA specific elements (2nd iteration)*
    - Before the development of scenario 1, WISE and TERESA specific elements will be re-assessed focusing on human factors, privacy and data and confidentiality issues.
  - *Task 2.3 - Scenario 2 development*
    - Identify the second business application. Evaluate and provide feedback to improve the edge Ai architecture.
  - *Task 2.4 - Final reports*
    - Complete comprehensive documentation for users and developers. Draft reports and request final documents.

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2.2.6. MAKE - PM50 (FLANDERS, BELGIUM): PREDICTIVE MAINTENANCE 5.0

DF Concept

Flanders Make is the Strategic Research Centre for the manufacturing industry in Flanders, Belgium. It has a strong expertise in the translation of industrial problems into suitable monitoring and control solutions, in particular for drive trains, production machines and vehicles. For its industrial research into Predictive Maintenance, Flanders Make has established a Smart Maintenance test infrastructure, consisting of a fleet of seven drive train setups with a whole range of sensors and advanced AI-in-the-cloud data processing to detect, diagnose and predict bearing faults in accelerated lifetime tests.

DF Plan

The aim of this experiment is upgrading the existing Smart Maintenance set-up from Industry 4.0 to Industry 5.0, with AI-on-the-edge data processing and easy-to-use human-machine interfacing for decision support. The two iterations of this Didactic Factory will then be used to provide training and dissemination events focused on SMEs, with the following objectives:

- to get maintenance technicians acquainted with new technologies in the domain of condition monitoring of industrial machines;
- to allow engineers to experience in a hands-on way some of the key technologies of Industry 5.0, as part of an up-skilling pathway towards successfully adopting I5.0;
- to ensure that decision makers are objectively informed, including business case analyses and sustainability aspects, about the ongoing global transition from I4.0 to I5.0.

The planned activities – Table 50, the milestones – Table 51, the deliverables – Table 52, and the expected results – Table 53 - are shown below.

Table 50 List of planned activities: MAKE - PM50

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Planning of Experiment - EXP (1)																																				
T2.1 - Execution of EXP – software (1)																																				
T2.2- Execution of EXP – hardware (1)																																				
T3 - Review of EXP - in the lab (1)																																				
T4 - Elaborating TERESA specific elements																																				
T5 - Review of EXP - in the field (1)																																				
T6 - Dissemination of EXP Results (1)																																				
T7 - Planning of EXP (2)																																				
T8.1 - Execution of EXP – software (2)																																				
T8.2 - Execution of EXP – hardware (2)																																				
T9 - Review of EXP - in the lab (2)																																				
T10 - Re-assessing TERESA specific elements																																				
T11 - Review of EXP - in the field (2)																																				
T12 - Final dissemination and exploitation																																				

Table 51 List of milestones: MAKE - PM50

N°	Milestone name	Date (month)
1	Architecture and monitoring system definition – Iteration 1.	M6
2	Validation of Iteration 1 (including WISE implications and TERESA aspects) under laboratory controlled conditions.	M10
3	Validation of Iteration 1 with volunteers from manufacturing SMEs, in accordance with TERESA-specific aspects.	M18
4	Architecture and monitoring system definition – Iteration 2.	M18
5	Validation of Iteration 2 (including WISE implications and TERESA aspects) under laboratory controlled conditions.	M24
6	Validation of Iteration 2 with volunteers from manufacturing SMEs, in accordance with TERESA-specific aspects.	M35

Table 52 List of deliverables: MAKE - PM50

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Monitoring system and architecture definition – Iteration 1	FLANDERS MAKE	Presentation	Confidential	M06
2	“AI for Smart Machines”	Professionals from manufacturing SMEs	Public demonstration of Iteration 1 at “Flanders AI Research Day” Symposium (16/10/2023)	Public	M10
3	Validation results and lessons learned from Iteration 1 (also with regard to WISE implications and TERESA aspects)	FLANDERS MAKE & AI REDGIO 5.0	Report	Confidential	M18
4	Monitoring system and architecture definition – Iteration 2	FLANDERS MAKE	Presentation	Confidential	M21
5	TBD	Professionals from manufacturing SMEs	Public demonstration of Iteration 2	Public	M24
6	Validation results and lessons learned from Iteration 2 (also with regard to WISE implications and TERESA aspects)	FLANDERS MAKE & AI REDGIO 5.0	Report	Confidential	M36

Table 53 Expected results: MAKE - PM50

N°	Result description	Date (month)
1	Implementation of AI models dedicated to AI-on-the-edge Condition Monitoring of rotating components using vibration measurement data	M12
2	AI-on-the-edge Didactic Factory (DF) Iteration 1, tested in industrial scenarios, and integrating AI models (from N°1), vibration sensors, acquisition / processing units and dashboard. WISE implications and TERESA aspects are covered in this DF.	M18
3	Implementation of AI models dedicated to AI-on-the-edge Condition Monitoring of rotating components using acoustic measurement data	M24
4	AI-on-the-edge Didactic Factory (DF) Iteration 2, tested in industrial scenarios, and integrating AI models (from N°3), acoustic sensors, acquisition / processing units and dashboard. WISE implications and TERESA aspects are covered in this DF.	M35

For a better understanding, in the following list a detailed description of each task is reported:

- *Task 1 – Planning of Experiment (1)*
    - Detailed planning, taking into account WISE implications and TERESA aspects, on how to upgrade the existing Smart Maintenance demonstrator from I4.0 to a I5.0 with AI-on-the-edge. First iteration of the Experiment. Define project objectives, scope, and success criteria.
- *Task 2*
    - *Task 2.1 - Execution of Experiment – software (1)*
        - Selection of relevant AI models and adaptation of corresponding code(base) towards AI-on-the-edge, implementation on Raspberry Pi and FAIM platforms, InfluxDB database, Grafana dashboard. WISE implications are taken into account.
    - *Task 2.2 - Execution of Experiment – hardware (1)*
        - Selection and integration of vibration sensors with Raspberry Pi and FAIM based processing unit(s) and Recovib acquisition system(s). TERESA risks and safeguards are taken into account.
- *Task 3 - Review of Experiment - in the lab (1)*
    - Testing I5.0 demonstrator in controlled laboratory conditions. WISE implications are verified.
- *Task 4 - Elaborating TERESA specific elements*
    - Prior to testing the demonstrator in-the-field, several TERESA aspects are further elaborated:
        - involvement of Competent Authority in setting up the tests and demonstrations of the Experiment
        - recruiting and engaging volunteers (focus on SMEs) for demonstrating and testing the Experiment
- *Task 5 - Review of Experiment - in the field (1)*

  - Demonstrating and Testing the I5.0 demonstrator in-the-field. Getting feedback on the human-machine interface, on the need for using other types of sensors and corresponding AI models. Assessing the validity of the assumptions regarding WISE implications and TERESA aspects of this First Iteration.

- *Task 6 - Dissemination of Experiment Results (1)*
  - Dissemination of the test results of the First Iteration of this I5.0 Demonstrator Experiment towards the local network as well as towards AI REDGIO 5.0 project partners.

- *Task 7 - Planning of Experiment (2)*
  - Iteration 2 of the Experiment will constitute a refinement of the human-machine interface, and of the models and acquisition methods used, taking into consideration the lessons learned from the First Iteration and the feedback received from the Experiment's volunteers. WISE implications and TERESA aspects are again considered.

- *Task 8*
  - *Task 8.1 - Execution of Experiment – software (2)*
    - Refinement of used AI models and selection/adaptation of additional AI models for the analysis of data from other types of sensors, taking into account WISE implications.
  - *Task 8.2 - Execution of Experiment – hardware (2)*
    - Selection and integration of (probably) acoustic sensors with the existing Raspberry Pi and FAIM based processing unit(s) and Recovib acquisition system(s). TERESA risks and safeguards are taken into account.

- *Task 9 - Review of Experiment - in the lab (2)*
  - Testing I5.0 demonstrator – Iteration 2 in controlled laboratory conditions. WISE implications are verified.

- *Task 10 - Re-assessing TERESA specific elements*
  - Prior to testing the 2nd Iteration of the Experiment in-the-field, the TERESA aspects are re-assessed:
    - involve Competent Authority in assessing 1st Iteration (with regard to WISE implications and TERESA aspects) and setting up the tests and demonstrations of the 2nd Iteration.
    - recruiting and engaging volunteers (focus on SMEs) for demonstrating and testing the 2nd Iteration.
- *Task 11 - Review of Experiment - in the field (2)*
  - Testing I5.0 demonstrator – Iteration 2 in-the-field. Getting final feedback on the human-machine interface, and on remaining barriers for SMEs to adopt AI-on-the-edge for Condition Monitoring on the factory floor. Final assessment the validity of the assumptions regarding WISE implications and TERESA aspects of this 2nd Iteration.

- *Task 12 - Final dissemination and exploitation*

- Dissemination and communication of project results within our local network and towards the AI REDGIO 5.0 project partners.
- One-on-one interviews with interested SMEs to evaluate future applications of the developed method.

2.2.7. DMWI - DIGITAL INNOVATION MANUFACTURING INNOVATION HUB (WALES, UK): INDUSTREWEB OPERATOR KNOWLEDGEBASE (IWOK)

DF Concept

The **Digital Manufacturing Innovation Hub Wales DMIW** is an independent DIH focused on the industrial commercialization of innovative technologies. DMIW facilitates a demonstration of the latest Industry 4.0 technologies including PLC and control systems connectivity, cloud-based data capture, AI Vision Systems, haptic feedback, CPS and embedded technologies, Gamification and multi-vendor integration across a range of digital and analogue sensors. In the framework of AI REDGIO 5.0 project, this experiment is focused on the use of **AI for decision making** in the manufacturing process.

DF Plan

The purpose of this experiment is to support the Contextualised Vision System experiment (CAP, C2K) by prototyping, testing and validating the concept of a self-healing, AI-driven knowledgebase. This DF experiment will take a typical production scenario, demonstrated using the Mini 'Didactic' Factory at the DMIW facility, and use the data to create a stream of information which the IWOK system can use to suggest a solution for a problem to the Operator. The Operator can use their 'human' sensors to verify the solution and confirm/decline the solution to 'teach' the machine how to fix the problem itself the next time the problem occurs. This experiment is motivated by the need to provide a higher degree of accuracy in automated problem solving and speed up a resolution using an AI-driven solution matrix. The DF experiment will produce results that will support the development of the live production experiment with CAP/C2K.

The planned activities – Table 54, the milestones – Table 55, the deliverables – Table 56, and the expected results – Table 57 - are shown.

Table 54 - List of planned activities: DMWI – Digital Manufacturing Innovation Hub

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1.1 - Project initiation																																				
T1.2 - Research and requirements gathering																																				
T1.3 - Evaluation framework development																																				
T1.4 - Scenario 1 development																																				
T2 - Feedback Analysis																																				
T2.1 - Scenario 2 development																																				
T2.2 - Final reports																																				

Table 55 List of milestones: DMWI – Digital Manufacturing Innovation Hub

N°	Milestone name	Date (month)
1	Evaluation framework implementation	M12
2	Prototype architecture description and improvements (including WISE implications and TERESA aspects)	M18
3	Final architecture description and improvements (including WISE implications and TERESA aspects)	M30

Table 56 List of deliverables: DMWI – Digital Manufacturing Innovation Hub

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Evaluation Framework		Report	Confidential	M12

	definition				
2	Prototype evaluation		Report	Confidential	M18
3	Framework updates		Report	Confidential	M24
4	Production evaluation		Report	Confidential	M30

Table 57 Expected results: DMWI – Digital Manufacturing Innovation Hub

N°	Result description	Date (month)
1	Define a framework to evaluate EdgeAi applications.	M18
2	Identify a set of significant evaluation scenarios for a distributed application.	M24
3	Improve the application architecture.	M35

- For a better understanding, in the following list a detailed description of each task is reported:***Task 1 – First iteration***
  - *Task 1.1 - Project initiation*
    - Define project objectives, scope, and success criteria.
  - *Task 1.2 - Research and requirements gathering*
    - Conduct an analysis of edge AI architectures in business applications. Define technical requirements for the platform. Research existing solutions and technologies in the field.
  - *Task 1.3 - Evaluation framework development*
    - Develop the architectural design of the platform (both hardware and software components). Implement the first a prototype of the platform for initial testing and feedback including WISE implications and TERESA aspects.
  - *Task 1.4 - Scenario 1 development*
    - Identify the business application. Evaluate and provide feedback to improve the Edge AI architecture.

- ***Task 2 – Second iteration***
  - *Task 2.1 - Feedback Analysis*
    - Evaluate the results of first scenario. Implements corrections and potential new requirements to the evaluation platform including WISE implications and TERESA aspects.
  - *Task 2.2 - Scenario 2 development*
    - Identify the second business application. Evaluate and provide feedback to improve the Edge AI architecture.
  - *Task 2.3 - Final reports*
    - Complete comprehensive documentation for users and developers. Draft reports and request final documents.

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2.2.8. MADE (LOMBARDY, ITALY): BEHAI – ADAPTING QUALITY INSPECTION SYSTEM TO HUMAN BEHAVIOR AND HUMAN STATES

DF Concept

MADE Competence Center is one of the 8 Italian Competence Centers and European Digital Innovation Hub by European Union. In the framework of AI REDGIO 5.0 project, the goal is to find a **direct relationship between environmental/biomechanical/biometrical data and the psychophysical state of the operator** so as to adapt the automated cycle to the condition of the human being, maximizing individual well-being and business productivity.

During the evolution of the BEHAI project, an operator doing quality control (already analysed by a traditional vision system) will be followed to obtain as much information as possible for the purpose of **adapting the behaviour of the robot** in charge of enslaving both the machine and the operator to the **psychophysical state of the operator**.

DF Plan

The BEHAI Experiment is directed to acquire data related to operators' stress, such as work environmental data (*e.g.*, temperature, pressure, humidity); biomechanical data (*e.g.*, postural effort); and biometric data through the following activities: analyse and acknowledge operators state, identify specific human state by associating AI feedback to the single operators, adapt manufacturing task to the identified state, decrease of costs linked to unskilled labour, decrease production costs, increase product quality and value (*i.e.*, decrease of defective components), upskilling of operators, increase of operator wellbeing and satisfaction, increase of operators' employability, higher employment rate of low skilled labour, inclusion of frail workers category.

The planned activities – Table 58, the milestones – Table 59, the deliverables – Table 60, and the expected results – Table 61 - are shown below.

Table 58 List of planned activities: MADE - BEhAI

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Design of requirements						X	X	X	X	X	X	X	X																							
T2 - Set Up														X	X	X	X	X																		
T3- AI Integration																			X	X	X	X	X	X												
T4 - Testing and Validation																								X	X	X	X									
T5 - Second iteration																												X	X	X	X	X	X			

Table 59 List of milestones: MADE - BEhAI

N°	Milestone name	Date (month)
1	Final list of sensors	M12
2	Data format definition	M12
3	Sensors arrival	M15
4	EDGE identification	M15
5	First AI algorithm	M22
6	Algorithm integration including WISE implications and TERESA aspects	M22
7	Trained algorithm	M23
8	Validation of KPI 1 (technical + WISE)	M27
9	Validation of KPI 2 (technical + WISE)	M27
10	Validation of KPI 3 (technical + WISE)	M27

Table 60 List of deliverables: MADE - BEhAI

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	TERESA Experiment report - M18	EAI	Report	C-EU/EU-C – EU Classified	M18
2	TERESA Experiment report – M36	EAI	Report	C-EU/EU-C – EU Classified	M36

Table 61 Expected results: MADE - BEhAI

N°	Result description	Date (month)
1	KPI final definition	M12
2	Purchases	M13
3	Examples of Data	M13
4	Identification of work conditions combination inside the experiment	M12
5	Hardware installation	M17
6	Systems integration	M17
7	Data pipeline	M18
8	Set-up completed	M18
9	AI model	M24
10	Final AI - trained and ready for experiment	M29
11	Validation of KPIs	M31
12	Technical report on the experiment	M33
13	Final internal report	M34

For a better understanding, in the following a detailed description of each task is reported:

- *Task 1 – Design of requirements*
  - Identification of KPIs, resources to be used, AI interface and requirements of the testing phase (*e.g.*, identification of competent authority, identification and recruitment of volunteers).
- *Task 2 - Set Up*
  - Implementation of the experiment by including the necessary sensors, and integrating the system (sensors, hardware, data pipeline), WISE KPIs monitoring and TERESA aspects.
- *Task 3 - AI Integration*
  - Definition of AI, its implementation inside the set up of the experiment and its training, taking into account adaptability features meeting WISE indicators.
- *Task 4 - Testing and Validation*
  - Actual testing phase of the experiment with KPI validation.
- *Task 5 - Second iteration*
  - A second phase of testing to have potential adjustments implemented inside the experiment. WISE implications and TERESA aspects will be included.

2.2.9. TUIASI I4.0 (ROMANIA): IMPLEMENTATION OF QAD-AI@E SOLUTION IN THE REAL CLOTHING MANUFACTURING ENVIRONMENT

DF Concept

The **TUIASI didactic factory** models Industry 4.0 innovative aspects of a production plant aiming to provide hands-on and interactive research and training in applications of advanced technologies. Its main components are: (i) autonomous omnidirectional robots; (ii) artificial vision systems; (iii) collaborative manipulator; (iv) 3D printed electronics manufacturing system. In the frame of AI REDGIO 5.0 project, this experiment is based on the KATTY Fashion (KAF) quality Assurance process described in Chapter 2.1.6. To overcome the manually inspection of clothes subjected to an individual evaluation, will be implemented AI models able to simplify QA tasks and **improve process efficiency and objectivity**.

DF Plan

QA is a tedious work that is very subjective and needs a lot of training data. Complexity of clothes produced by KAF is high. Currently all the QA at KAF is done manually, a phone being used to document relevant issues of later training of the production team or improvement of production workflows. The AI part of the QUAD-AI@E system will deploy Computer Vision related algorithms for preprocessing and AI processing of the captured image. Multiple algorithms for pre-processing are analysed in conjunction with a supervised learning AI. In deep analysis of defects for segmentation of provided good/bad annotated images is ongoing. The results of the hands-on analysis will decide the direction of the AI design. The AI technology used will be of the Fuzzy systems type, in this sense it is useful to create and train a database with possible defects in clothe.

The planned activities – Table 62, the milestones – Table 63, the deliverables – Table 64, and the expected results – Table 65 - are shown below.

Table 62 List of planned activities: TUIASI – I4.0

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Management activities																																				
T2 - Observation of technical problems in fashion QA and analysis of technical solutions																																				
T3- Development of the EM-QUAD-AI@E experimental model																																				
T4 - Development of the Py-QUAD-AI@E prototype																																				
T5 - Creation of a database of defects in clothe																																				
T6 - Dissemination of results																																				

Table 63 List of milestones: TUIASI – I4.0

N°	Milestone name	Date (month)
1	EM-QUAD-AI@E architecture	M9
2	EM-QUAD-AI@E Experimental model	M20
3	Py-QUAD-AI@E prototype	M32
4	Edge AI computing system	M27
5	Fuzzy AI algorithms dedicated to video processing	M20
6	Scientific papers based on Fuzzy AI algorithms	M22
7	Final documentation of the project	M32

Table 64 List of deliverables: TUIASI – I4.0

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Project Overview and Status Update	TUIASI/KF	Presentation	Public	M11
2	Showcase the experiment in a workshop	TUIASI/KF	Presentation	Public	M13
3	Experimental Model of EM-QUAD-AI@E - technical documentation	TUIASI	Document	Confidential	M17
4	Py-QUAD-AI@E prototype - technical documentation	TUIASI	Document	Confidential	M36
5	Documentation of the integrated project (including WISE and TERESA issues)	TUIASI/KF	Document	Confidential	M36

Table 65 Expected results: TUIASI – I4.0

N°	Result description	Date (month)
1	EM-QUAD-AI@E Experimental model	M20
2	Py-QUAD-AI@E prototype	M36
3	Database of clothes defects	M33
4	Documentation of the integrated project	M36

- For a better understanding, in the following list a detailed description of each task is reported:***Task 1*** *– Management activities*
    - Task 1.1 - Organizing team activities, allocating resources and delegating tasks respecting TERESA ethical and regulatory issues (M1 – M36).
    - Task 1.2 - Participation in meetings organized by the project management teams (M1 – M36).
    - Task 1.3 - Reporting the results of activities (M1 – M36).
- ***Task 2*** - *Observation of technical problems in fashion QA and analysis of technical solutions*
    - Task 2.1 - Analysis of technical issues in the quality assessment process in cooperation with Katty Fashion (respecting TERESA and WISE ethical and regulatory issues) – KF (M1-M4).
    - Task 2.2 - Analysis of some models of clothes with defects, developed by KF (M3-M12).
    - Task 2.3 - Classification of defects identified in clothes (M3-M12).
    - Task 2.4 - Organization of Brainstorming sessions in order to identify technical solutions respecting TERESA and WISE ethical and regulatory issues (TUIASI+KAF) (M1-M9)
- ***Task 3*** - *Development of the EM-QUAD-AI@E experimental model*
    - *Task 3.1* - HW equipment development

        - Task 3.1.1 - Mechanical HW
            - Conceiving and design/purchase of a video camera positioning frame;
            - Conceiving and design/purchase of a clothes rack.
        - Task 3.1.2 - Electronic HW
            - Conceiving and design of a block diagram of the electronic data acquisition equipment;
            - Conceiving and design of a block diagram of the data processing equipment.
        - Task 3.1.3 - Integration of mechanical HW + electronic HW
    - *Task 3.2* - SW platform development
        - *Task 3.2.1* - Development of AI algorithms dedicated to detecting defects in clothes
        - *Task* 3.2.2 - Development of simulation functions in the MATLAB simulation environment
        - *Task 3.2.3* - Development of firmware models for the edge-computing AI device
        - *Task 3.2.4* - Integration of the electronic module of the experimental model EM-QUAD-AI@E
    - *Task 3.3* - HW + SW integration of the EM-QUAD-AI@E experimental model
    - *Task 3.4* - Testing and validation of the EM-QUAD-AI@E experimental model (respecting TERESA ethical and regulatory issues)

- ***Task 4*** - *Development of the Py-QUAD-AI@E prototype*
    - *Task 4.1* - HW equipment development
        - *Task 4.1.1* - Conception and design of the electronic acquisition and data processing module (block diagram + electronic diagram + PCB circuits);
        - *Task 4.1.2* - Assembling the electronic procurement and data processing module.
    - *Task 4.2* - SW platform development
        - *Task 4.2.1 - Development* of the firmware program dedicated to AI processing
    - *Task 4.3* - HW + SW integration of Py-QUAD-AI@E prototype
    - *Task 4.4* - Testing and validation of the Py-QUAD-AI@E prototype
- ***Task 5*** - *Creation of a database of defects in clothes*
    - *Task 5.1* - TUIASI will provide to KF with equipment for capturing images and storing them in a database. This activity will be performed respecting TERESA ethical and regulatory issues.
    - *Task 5.2* - KAF will assign an operator who will capture the images, identify the defects in the clothes through the images and save the images in the local database.

- *Task 5.3* - TUIASI will use the database (D2) to train the AI learning process so that it can automatically identify defects in clothes, when analysing new images, in the QA process. Validation of data-base based on TERESA ethical criteria

- ***Task 6*** *- Dissemination of results*
  - *Task 6.1* - Editing of scientific papers
  - *Task 6.2* - Participation in conferences and workshops (by respecting of WISE and TERESA criteria).

2.2.10. CTU RICAIP (CZECH REPUBLIC): AI-DRIVEN MONITORING OF ROBOTIC ASSEMBLY PROCESS

DF Concept

The Czech Technical University in Prague (CTU), stands as one of Europe's oldest technical universities and is a paramount institution in the Czech Republic, renowned for its high-calibre education and a venerable tradition of pioneering science and engineering. The institute endeavours to centralize exceptional research in the domains of robotics, intelligent systems, distributed and complex systems, automatic control, computer-aided manufacturing, bioinformatics, and biomedicine

DF Plan

The main objective of this experiment is to detect a problem in the assembly process as quickly as possible from the cheap force and torque sensors. This can improve quality of the assembled parts and final product and reduce scrap rate of the assembly operation. This implies a reduction of the costs of nonconformance, but simultaneously the faster production will lead to a higher productivity.

the planned activities – Table 66, the milestones – Table 67, the deliverables – Table 68, and the expected results – Table 69 - are shown below.

Table 66 - List of planned activities: CTU - RICAIP

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Offline data acquisition																																				
T2 - NonOK state detection methods																																				
T3- AI at the edge preparation																																				
T4 - TERESA related activited																																				
T5 - At the edge implementation																																				
T6 - Alignment with other WPs (platforms, eDIHs)																																				
T7 - Final testing																																				

Table 67 List of milestones: CTU - RICAIP

N°	Milestone name	Date (month)
1	All needed offline data acquired	M12
2	Edge AI equipment chosen and ready	M15
3	Detection methods proposed and evaluated offline	M15
4	At the edge model is available	M18
5	Final model offered via eDIH as a service or via platforms	M21

Table 68 List of deliverables: CTU - RICAIP

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Technical report "Model for repetitive processes anomaly detection from data streams"	CTU	Technical report	Public	M15

Table 69 Expected results: CTU - RICAIP

N°	Result description	Date (month)
1	Toolbox implementing functions needed for the final detector, its testing and development	M15
2	Finished nonOKstate detector implemented at the edge of delta robot	M21

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 – Offline data acquisition*
    - Force and torque data for tens of assembled parts will be acquired and stored.
- *Task 2 - NonOK state detection methods*
    - At least two methods for the detection will be chosen after a comprehensive survey, implemented and tested off-line.
- *Task 3 - AI at the edge preparation*
    - Selection of the edge AI solution, preparation of equipment.
- *Task 4 – TERESA related activities*
    - Interaction with Competent Authority, collecting volunteers and performing assessment of ethical and regulatory issues.
- *Task 5 - At the edge implementation*
    - Final implementation of the edge AI solution including WISE implications and TERESA aspects.
- *Task 6 - Alignment with other WPs (platforms, eDIHs)*
    - Communication with eDIH, exposure on DIH related portals and platforms.
- *Task 7 - Final testing*
    - Final testing and evaluation and final bugs removal.

2.2.11. AAU SMART LAB (DENMARK): AAU ADVANCED IOT

DF Concept

The **AAU Smart Lab** at Aalborg University is a "small Industry 4.0 factory" integrating and demonstrating Industry 4.0 technologies, built around FESTOs CP factory, which is a small modular, and expandable factory integrating many relevant Industry 4.0 technologies. In the framework of AI REDGIO 5.0, the experiment will update the AAU IoT suitcase with data analytics/machine learning capabilities.

DF Plan

The experiment will update the AAU IoT suitcase so that it includes data analytics capabilities. The experiment will serve as a reference use case for other product segments in the SME as well for other SME machine builder and user companies. The objectives of the experiment aim to:

- improve operational efficiency by collecting and analysing data from sensors, allowing SMEs to identify and optimize inefficiencies in their production and operations;
- enhance product quality through the use of IoT data, enabling real-time monitoring, and prompt corrective actions;
- improve the company image of SMEs by showcasing a commitment to innovation and technology, thereby enhancing their reputation and attracting new customers.

The planned activities – Table 70, the milestones – Table 71, the deliverables - Table 72 and the expected results – Table 73 - are shown below.

Table 70 List of planned activities: AAU - SMART LAB

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Experiments (1) – Data Analysis Methods																																				
T2 - Experiments (2) – Integrate AAU IoT Box																																				
T3- Summarize Findings																																				

Table 71 List of milestones: AAU - SMART LAB

N°	Milestone name	Date (month)
1	Experiment (1) - setup in AAU Smart Lab (e.g., setup UR robot, PLC controller and sensors)	M3
2	Experiment (1) - Building data collection and processing methods	M6
3	Experiment (1) - Building and evaluating machine learning methods	M9
4	Experiment (2) preparation in SME (KP Components), e.g., investigating the production system, analyzing workflow, identifying possible sensors for use	M15
5	Experiment (2) - Integrate AAU IoT Box in production system	M17
6	Experiment (2) - evaluation (including WISE implications and TERESA aspects)	M20
7	Disseminate the Knowledge	M23

Table 72 List of deliverables: AAU - SMART LAB

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Experiment overview	AAU	Report	Confidential	M6
2	Business requirements	AAU	Report	Confidential	M9
3	Implementation and results at M21	AAU	Report	Confidential	M21

Table 73 Expected results: AAU - SMART LAB

N°	Result description	Date (month)
1	By applying our data analysis methods, the production quality (*e.g.*, anomaly detection accuracy) is improved. Our data processing methods and machine learning algorithms are available on our GitHub repository.	M9
2	AAU IoT Box will be integrated in the production system of KP components company. AAU IoT box will provide real time data monitoring, collection and visualization. WISE implications and TERESA aspects are covered in this DF.	M20
3	Promote knowledge sharing through platforms like conference, workshops or webinars, make research methods and tools openly accessible to encourage broader contributions and advancements in the field.	M23

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 – Experiments – Data Analysis Methods*
    - The experiments consist of three phases. The initial phase involves an exploration of data analysis methods. Specifically, the experiment centers around the selection, design, and evaluation of machine learning algorithms tailored for analysing sensor data in a robot screwing cell. The experiment is conducted at AAU Smart Lab in collaboration with Velux (large crop), taking into account WISE implications and TERESA aspects.
- *Task 2 – Experiments – Integrate AAU IoT Box*
    - The experiment will take place at KP Components, a Danish SME. The focus of the experiment is to integrate AAU IoT with their production system. The IoT Box will utilize data analysis methods from previous experiments to extend the lifetime of cutting tools. WISE implications are verified.
- *Task 3 – Summarize Findings*
    - Spread the knowledge through avenues such as workshops and webinars, initiate collaborations with potential partners, and make methods and tools open-source for wider accessibility and contribution.

2.2.12. PBN amLAB (HUNGARY): SUNSYNC: AI SOLUTION FOR OPTIMIZING RECYCLING IN INDUSTRY AT THE LEVEL OF AM-LAB'S DF

DF Concept

am-LAB is a digital innovation hub and advanced manufacturing laboratory focuses on digital technologies, robotics, data science, extended reality and 3D technologies. A broad portfolio of connected technological devices is available in the laboratory, with in-house engineering staff. The technology transfer department cooperates with multinational technology suppliers from one side (SMC, UR, Formlabs, Keyence, etc) from the technology supplier side, and with a wide range of manufacturing companies from the customer side (Aptiv, IKEA, Ivy, TDK, MAM, Linde, etc.). The most recent technological development is a teaching and learning factory solution, an advanced demonstration and research-oriented production line with 6 stations, provided by SMC Corporation. It enables such in-house development like real-time data visualisation, augmented reality applications, predictive statistics, neural network-based image recognition. am-LAB was awarded the best digital innovation hub title of 2020, awarded at the first European Digital Innovation Hub conference.

The experiment uses AI to improve energy efficiency and recycling by making smart real-time decisions based on data from various sources, promoting sustainability and reducing environmental impact.

This experiment aims to solve two main challenges:

- Energy Efficiency: we would like to make the best use of energy in systems that use solar panels and energy storage accumulators.
- Recycling Optimization: we aim to schedule recycling processes smartly to use clean energy efficiently and reduce reliance on non-renewable sources.
-

DF Plan

In summary, this experiment is directed to:

- Automating and Optimizing Recycling Processes: Streamlining current recycling methods to enhance efficiency and output;
- Utilizing Solar Power as Primary Energy Source: Committing to renewable energy to minimize environmental impact and promote sustainability;
- Battery Life Extension: Focusing on maintaining the battery in its optimal operating condition ('sweet spot') to prolong its lifespan.
- Data-Driven Decision Making: Leveraging data analysis as a fundamental tool for informed decision-making throughout the project.

The planned activities – Table 74, the milestones – Table 75, the deliverables – Table 76, and the expected results – Table 77 - are shown below.

Table 74 List of planned activities: PBN - amLAB

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Research Initiation																																				
T2 - Stable Recycling Data Collection																																				
T3- Stable Recycling Control Environment																																				
T4 - First Version of AI Model Developed																																				
T5 - Stable Battery Data																																				

Collection									■																											
T6 - New Version of Forecast Data Collection is Stable											■																									
T7 - Basic Version of Each System Component Prepared											■																									
T8 - Integration and Demo Preparation												■	■	■	■																					
T9 - Assessment of the WISE aspects_Interim																■	■																			
T10 - Foundation Data Collection for AI Model												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
T11 - Stress Testing and Model Enhancement															■	■	■	■	■	■	■	■														
T12 - General Solution Development																						■	■	■	■	■	■	■	■	■						
T13 - Testing of Generalized Solution																														■	■	■	■			
T14 - Documentation of General Solution																																	■	■	■	■
T15 - Assessment of the WISE aspects_FINAL																																			■	■

Table 75 List of milestones: PBN - amLAB

N°	Milestone name	Date (month)
1	Stable Recycling Data Collection	M8
2	Stable Recycling Control Environment	M8
3	First Version of AI Model Developed	M9
4	Stable Battery Data Collection	M9
5	New Version of Forecast Data Collection is Stable	M11
6	Basic Version of Each System Component Prepared	M11
7	Integration of Each System Component and Demo Preparation	M15
8	Generalized Solution based on the Demo	M33
9	Documentation of General Solution	M36

Table 76 List of deliverables: PBN - amLAB

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	Project Overview and Status Update	PBN	Presentation	Public	M11
2	Showcase the experiment in a workshop	PBN	Presentation	Public	M13
3	Validation results and lessons learned from Iteration 1 (also with regard to WISE implications and TERESA aspects)	PBN	Report	Confidential	M17
4	Validation results and lessons learned from Iteration 2 (also with regard to WISE implications and TERESA aspects)	PBN	Report	Confidential	M36

Table 77 Expected results: PBN - amLAB

N°	Result description	Date (month)

1	Prototype for System Improvement (Bug Identification and Enhancements)	M14
2	Finished Demo with Full System Integration	M24
3	Generalized Solution based on the Demo	M33
4	Documentation of General Solution	M36

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 - Research Initiation*
    - Initiated research in the field of recycling automation and solar energy.
- *Task 2 - Stable Recycling Data Collection*
    - Achieved stable data collection for recycling processes.
- *Task 3 - Stable Recycling Control Environment*
    - Ensured stability in the recycling control environment.
- *Task 4 - First Version of AI Model Developed*
    - Developed the initial version of the AI model for recycling optimization.
- *Task 5 - Stable Battery Data Collection*
    - Achieved stable data collection related to battery performance.
- *Task 6 - New Version of Forecast Data Collection is Stable*
    - Ensured stability in the newly updated forecast data collection.
- *Task 7 - Basic Version of Each System Component Prepared*
    - Completed the basic versions of all system components.
- *Task 8 - Integration and Demo Preparation*
    - Assembled all individual system components for an integrated demo. This phase involves combining the automation, AI model, and data collection systems into a cohesive unit for demonstration purposes. The demo, at this stage, is designed to operate exclusively within our controlled environment, showcasing the functionality and potential of the project as a whole.
- *Task 9 - Assessment of the WISE aspects_Interim*
    - A selected volunteer will assess (in the framework of Well-being, Comfort and Acceptance) the use of technology how it can affect mental well-being, self-esteem, and autonomy. It's essential to balance convenience with potential frustration and emotional dependence. Ensuring human dignity, oversight, and trust in human-machine collaboration is crucial for responsible technology integration. The volunteer will also assess the Inclusion and special categories of worker with ensuring that technology is inclusive and accessible to all individuals, including those with special needs or from underrepresented categories. It involves accommodating diverse abilities, backgrounds, and circumstances to promote equal opportunities and fair treatment in technology-related contexts.

- *Task 10 - Foundation Data Collection for AI Model*
    - Commenced the collection of foundational data critical for the development of an enhanced AI model. This stage involves systematically gathering diverse, high-volume, and high-quality data sets that are fundamental to training the AI.
- *Task 11 - Stress Testing and Model Enhancement*
    - Conducted comprehensive stress tests on the integrated system to evaluate its robustness and reliability under various scenarios and extreme conditions. Concurrently, refined and enhanced the AI model, focusing on improving its accuracy, efficiency, and adaptability. This phase is crucial for ensuring the system's resilience and optimizing its performance before wider implementation.
- *Task 12 - General Solution Development*
    - Transitioned from a specific, controlled experiment to the creation of a generalized solution applicable in diverse environments. This phase involves adapting and refining the AI model and system components to ensure versatility, scalability, and adaptability. The goal is to produce a robust solution that can be effectively implemented in different settings, accommodating varying scales and specific needs of different energy management systems.
- *Task 13 - Testing of Generalized Solution*
    - Tests are designed to assess the solution's effectiveness in various conditions, identifying any areas that require further refinement. The objective is to ensure that the solution is not only versatile but also consistently delivers high performance and meets the varied needs of different and energy systems.
- *Task 14 - Documentation of General Solution*
    - Finalized comprehensive documentation of the General Solution, detailing the methodologies, processes, and guidelines necessary for replicating our experiment in different environments.
- *Task 15 - Assessment of the WISE aspects_FINAL*
    - A selected volunteer will assess (in the framework of Well-being, Comfort and Acceptance) the use of technology how it can affect mental well-being, self-esteem, and autonomy. It's essential to balance convenience with potential frustration and emotional dependence. Ensuring human dignity, oversight, and trust in human-machine collaboration is crucial for responsible technology integration. The volunteer will also assess the Inclusion and special categories of worker with ensuring that technology is inclusive and accessible to all individuals, including those with special needs or from underrepresented categories. It involves accommodating diverse abilities, backgrounds, and circumstances to promote equal opportunities and fair treatment in technology-related contexts.

2.2.13. GRADIANT - GALICIA INDUSTRIAL LOGISTICS LAB (SPAIN): GALICIA DF

DF Concept

GAIN Axencia Galega de Innovacion is an agency for innovation and technology transfer located in Galicia, Spain. This DF is focused on the application of AI and Edge technologies in an industrial robot environment. Within the AI REDGIO 5.0 project, the main aim of the experiment carried on by this DF is to provide a system where AI/ML models can be deployed in order to study approaches to optimize a virtualized production process both from the operational and energy efficiency points of view. Thus, the DF aims to be a testing environment where novel algorithms and approaches can be tested with the available process data in order to research improvements that could be further optimized later in a real environment.

DF Plan

The experiment is directed to:

- create a test bed in Galicia for novel Edge & AI technologies applied to manufacturing with an I5.0 approach
- serve as a valuable learning opportunity for gaining hands-on experience with cutting-edge technologies
- boost collaboration among relevant actors in Galicia and create a joint approach for I5.0
- promote economic growth in the region
- sync efforts between European projects.

The planned activities – Table 78, the milestones – Table 79, the deliverables – Table 80, and the expected results – Table 81 - are shown below.

Table 78 List of planned activities: GRADIANT – Galicia Industrial Logistics Lab

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
T1 - Definition of the Galicia DF's location and features																																				
T2 - Exploratory Data Analysis and Industrial Assets Identification																																				
T3- Initial design of experiment																																				
T4 - Integration of Edge devices in the facilities																																				
T5 - First version implementation of ETL process																																				
T6 - First version implementation of AI-Edge models																																				
T7 - First version implementation of optimization module																																				
T8 - First version implementation of orchestration Framework																																				
T9 - First integration and validation of experiment																																				
T10 - Design of a dissemination plan for the DF's services																																				
T11 - Definition and involvement of the																																				

Month → Task↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Competent Authority																																				
T12 - Refinement of the experiment's design																																				
T13 - Second version implementation of ETL process																																				
T14 - Second version implementation of AI-Edge models																																				
T15 - Second version implementation of optimization module																																				
T16 - Second version implementation of orchestration Framework																																				
T17 - Final integration and validation of experiment																																				
T18 - Refinement and implementation of the dissemination plan for the DF's services																																				

Table 79 List of milestones: GRADIANT – Galicia Industrial Logistics Lab

N°	Milestone name	Date (month)
1	First design of experiment	M9
2	First version implementation of all experiment's components	M18
3	Deployment and validation of the first version implementation	M21
4	Final design of experiment	M23
5	Second version implementation of all experiment's components	M36
6	Deployment and validation of the final implementation	M36
7	Involvement of volunteers to visit and test the DF's features and assess the WISE implications	M36

Table 80 List of deliverables: GRADIANT – Galicia Industrial Logistics Lab

N°	Deliverable Name	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
1	First design of experiment	Gradiant	Doc		M9
2	First version implementation of all experiment's components	Gradiant	Doc/SW		M18
3	Deployment and validation of the first version implementation	Gradiant	Doc		M21
4	Final design of experiment	Gradiant	Doc		M23
5	Second version implementation of all experiment's components	Gradiant	Doc/SW		M36
6	Deployment and validation of the final implementation	Gradiant	Doc		M36

Table 81 Expected results: GRADIANT – Galicia Industrial Logistics Lab

N°	Result description	Date (month)
1	Definition of the requirements and scope of the experiment	M6
2	Initial design of the experiment's architecture	M9
3	First version implementation of the forecasting module	M18
4	First version implementation of the optimization and prescription module	M18
5	First version implementation of the orchestration framework	M18
6	Deployment and validation of the first version of all the experiment's components	M21
7	Final design of the experiment's architecture	M23
8	Second version implementation of the forecasting module	M36
9	Second version implementation of the optimization and prescription module	M36
10	Second version implementation of the orchestration framework	M36
11	Deployment and validation of the final version of all the experiment's components	M36
12	Dissemination of the DF's services that attracts visits to the facilities	M36
13	Collection and evaluation of feedback from the volunteers regarding the features and WISE implications of the DF	M36

- For a better understanding, in the following list a detailed description of each task is reported:*Task 1 - Definition of the Galicia DF's location and features*
    - Definition of the requirements and scope of the experiment, including the design of the features and services that will be offered in the DF's facilities.
- *Task 2 - Exploratory Data Analysis and Industrial Assets Identification*
    - Identification and compilation of the industrial assets and process variables that will be retrieved from the systems of the DF's facilities and used for the implementation of the experiment. This also includes the preliminary collection and analysis of all data sources available from DF's assets.
- *Task 3 - Initial design of experiment*
    - In detailed both functional and technical design of the DF's test bed, including: Extract-Transform-Load required processes from the collection and pre-processing of data from assets; edge computing AI models for real-time forecasting of KPIs; cloud-based production optimization service from the edge-computing AI model's outputs; Framework for the orchestration of all experiment's components; integration of experiment's architecture with AIREDGIO5.0 platform.
- *Task 4 - Integration of Edge devices in the facilities*
    - Integration of hardware to complement the current manufacturing lines of the DF, located at AIMEN's facilities, with Edge devices, with the purpose of providing AI service orchestration.
- *Task 5 - First version implementation of ETL process*
    - Technical development of the first version of the required ETL process, based on the previous analysis and experiment's design.

- *Task 6 - First version implementation of AI-Edge models*
  - Technical development of the first version of Edge-computing AI models for production quality forecasting, based on the previous analysis and experiment's design.
- *Task 7 - First version implementation of optimization module*
  - Technical development of the first version of the cloud-based service for optimization of production quality, based on the previous analysis and experiment's design.
- *Task 8 - First version implementation of orchestration Framework*
  - Technical development of the first version of the orchestration framework for AI models within the IT infrastructure, based on the previous analysis and experiment's design.
- *Task 9 - First integration and validation of experiment*
  - Integration, deployment and testing of the first version of the experiment's components, deploying, running and orchestrating the AI services developed on the Edge devices provided. This will allow us to validate, both functionally and technically, the whole solution.
- *Task 10 - Design of a dissemination plan for the DF's services*
  - Design of a plan for disseminating the testbed that will be provided through this Didactic Factory for novel Edge & AI technologies with an I5.0 approach, so companies and students can visit the facilities and learn their use for their purposes. This will provide a plan for attracting volunteers and validating the experiment during the second iteration.
- *Task 11 - Definition and involvement of the Competent Authority*
  - Selection, contact and involvement of a Competent Authority (CA) in the Didactic Factory experiment. During the whole duration of the experiment, continuous exchanges of information are expected between the experiment team and this entity. These bilateral meetings will allow enhancing knowledge about the potential challenges and risks, and reducing regulatory and ethical uncertainty in the experiment.
- *Task 12 - Refinement of the experiment's design*
  - Refinement of the initial functional and technical design of the DF's testbed, including all the components considered in the first version. It will be based on the lessons learned from the first iterations.
- *Task 13 - Second version implementation of ETL process*
  - Technical development of the second version of the required ETL process, refining and complementing the first version implementation. The lessons learned from the first iteration of the experiment will be applied and additional features might be implemented in order to provide the final implementation of this module.
- *Task 14 - Second version implementation of AI-Edge models*
  - Technical development of the second version of Edge-computing AI models for production quality forecasting, refining and complementing the first version

implementation. The lessons learned from the first iteration of the experiment will be applied in order to provide the final implementation of this module.

- *Task 15 - Second version implementation of optimization module*
    - Technical development of the second version of the cloud-based service for optimization of production quality, refining and complementing the first version implementation. The lessons learned from the first iteration of the experiment will be applied and additional features might be implemented in order to provide the final implementation of this module.
- *Task 16 - Second version implementation of orchestration Framework*
    - Technical development of the second version of the orchestration framework for AI models within the IT infrastructure, refining and complementing the first version implementation. The lessons learned from the first iteration of the experiment will be applied and a more advanced orchestration framework is expected to be implemented in order to provide the final implementation of this module.
- *Task 17 - Final integration and validation of experiment*
    - Integration, deployment and testing of the second version of the experiment's components, deploying, running and orchestrating the enhanced AI services developed on the Edge devices provided. This will allow us to validate, both functionally and technically, the whole final solution.
- *Task 18 - Refinement and implementation of the dissemination plan for the DF's services*
    - Refinement and implementation of the plan for disseminating the DF's services, which was initially designed during the first iteration of the experiment. It will spread information about the test bed that will be provided through this Didactic Factory for novel Edge & AI technologies with an I5.0 approach, so companies and students can visit the facilities and learn their use for their purposes. The implementation of this plan, which aims at involving volunteers, will provide validation for this experiment. The feedback collected from these volunteers through the means defined in the dissemination plan (interviews, questionnaires, etc.) will allow us to assess the WISE implications in the DF

3. Conclusion and Future Work

The deliverable has presented the experiment plan of the 7 SME-driven Experiments and the 14 Didactic Factories Experiments.

Milestones, deliverables and activities for each experiment have been described in detail.

The next steps related to the activities in this work package will focus on the continuous monitoring and evaluation of the experiments; in particular:

- T6.2 will follow-up on the 3 SME-driven Experiments belonging to the AI REGIO project regions;
- T6.3 will monitor the 4 SME-driven Experiments belonging to the AI PILOT regions (Vanguard Initiative);
- T6.4 will oversee the 14 Didactic Factories Experiments.

At month 18 the first iteration of the experiments will be concluded and the prototypes will be ready. – D6.2 and D6.3.

Moreover, in Deliverable 6.4 "TERESA Experiments in TEF Network "a focus on WISE aspects will be presented at month 18.

At month 24, the D6.5 will report the experiments' plan for the second iteration.