AI Platform for Integrated Sustainable and Circular Manufacturing

Deliverable

D2.1 Requirements Engineering Methodology - 1st version

Actual submission date: 30/09/2022

Funded by
the European Union

Project Number:	101058585		
Project Acronym:	Circular TwAIn		
Project Title:	AI Platform for Integrated Sustainable and Circular Manufacturing		
Start date:	July 1st, 2022	**Duration:**	36 months
D2.1 Requirements Engineering Methodology - 1st version			
Work Package:	WP2		
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Due date:	30/09/2022		
Deliverable Type:	R	**Dissemination Level:**	PU
Version number:	1.0		

Revision History

Version	Date	Author	Description
0.1	29/07/2022	POLIMI	TOC
0.2	18/08/2022	POLIMI	First draft
0.3	05/09/2022	POLIMI	Second draft
0.4	13/09/2022	POLIMI, EAI	Third draft
	15/09/2022	FhG-IOSB	Review
	20/09/2022	SUITES	Review
0.5	27/09/2022	POLIMI	Final Version
1.0	30/09/2022	ENG	Final coordinator review before submission

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Definitions and acronyms

AI	*Artificial Intelligence*
BEinCPPS	*Business Experiments in Cyber Physical Production Systems*
CA	*Consortium Agreement*
DIH	*Digital Innovation Hub*
DoA	*Description of Action*
EC	*European Commission*
EL	*Ethical and Legal*
EPIA	*Ethics Impact Assessment*
EU	*European Union*
GA	*Grant Agreement*
GRAI	*Graphs with Results and Actions Inter-related*
H/O	*Human/Organization*
KPI	*Key Performance Indicator*
MDSEA	*Model Driven System Engineering Architecture*
Mx	*Month x*
PPE	*Personal Protection Equipment*
PC	*Project Coordinator*
PIS	*Performance Indicator Systems*
PM	*Physical Means*
RE	*Requirements Engineering*
SE	*Software Engineering*
TC	*Technical Coordinator*
WP	*Work Package*
THB	*Trial Handbook*
TechHB	*TechHB*
V&V	*Verification & Validation*

Disclaimer

Executive Summary

D2.1 Requirements Engineering Methodology is the first deliverable of WP2 and aims to achieve one of the main objectives of WP2: to define methodologies and tools to elicit and structure user and system requirements and support the definition and constant verification and validation of Performance Indicators.

This deliverable is associated to T2.1 Requirements Engineering Method for Circular TwAIn, which establishes two main objectives intended to assess through this first deliverable:

1. To analyse the industrial pilots' scenarios and extract the requirements for the Methodological Framework (WP3) the Data Space for Circularity (WP4) and for the AI implementation toolkit (WP5).
2. To define Performance Indicators at the different levels and to put in place the proper mechanisms and procedures to constantly measure and assess them.

Therefore, D2.1 defines a common methodology for the continuous requirements gathering, validation and assessment of the project activities, sets the procedure for the application of the established methodology and builds up a set of indicators for its correct implementation.

The Requirements Engineering and Industrial Verification and Validation Method is based on MDSEA (Model Driven System Engineering Architecture), a result of BEinCPPS H2020 I4MS project[1]. The requirements will be documented, categorised, prioritised, and communicated with the partners in charge of developing the methodologies and tools for their final refinement in piloting WPs.

The initialisation of the assessment of the project business impact on the industrial pilots (i.e. project success in terms of satisfaction of pilots' objectives) will be supported by ECOGRAI[2] method which allows the definition of Performance Indicators.

All this information will be included in structured Handbooks:

- Trial Handbook, which is the reference document for the whole lifecycle of the three industrial pilots and their use cases.
- Techno Handbook, which is the reference document for the whole lifecycle of the technical developments (Data Space, AI-based Digital Twins, AI Toolkit).

The Requirements Engineering and Industrial Verification and Validation Method described in this deliverable enables and supports the compilation of information through both the Trial Handbook and the Techno Handbook.

The responsible partner of each instrument, phase and activity to be carried out within the Requirements Engineering and Industrial Verification and Validation Method is established in the D2.1 "Circular TwAIn Requirements Engineering Methodology"; as well as the expected timeline.

[1] *http://www.beincpps.eu*
[2] *https://link.springer.com/chapter/10.1007/978-0-387-34847-6_39*

The compliance with the methodology outlined in this deliverable will ensure that the expected results are achieved within the project and the correct development of all the work packages and deliverables.

I Introduction

1.1 Scope of the document

This deliverable aims to define a methodology for capturing the needs and business requirements of the project's pilots and asses the project's business impact on the industrial pilots. It will have further impact in other tasks and deliverables.

Deliverable D2.1 "Circular TwAIn Requirements Engineering Methodology" delivered at M3 contributes to:

- WP2 – User Scenarios, Requirements and socio-economic Assessment
- WP3 – Conceptual Framework and Reference Architecture
- WP4 – Data Space for Circular and Resilient Manufacturing
- WP5 – AI-enabled Digital Twins for distributed manufacturing
- WP6 – Industrial Pilots & Circular Manufacturing Experimentations

The deliverable D2.1 impacts specific tasks within WP2, by defining a common methodological framework for the requirements gathering within the project. D2.1 contributes to T2.2 "Circular Industrial Frameworks and Data Spaces scenarios", which aims to analyse together with the industrial pilots the need for common Data Spaces for Circular value chains. It will also have direct impact on T2.3 "Specification of the Circular TwAIn Ecosystem", which aims to specify the ecosystem of AI based Digital Twins to be developed in WP5. Additionally, it impacts T2.4 "Socio-technological-business-ethical continuous assessment and 6Ps Transformation", which aims to define roles, responsibilities and procedures for assessing the socio-economic and ethical impact of the Enterprises involved in the experiments. D2.1 is also directly contributing to WP6 as it sets the methodology for the information gathering, progress and monitoring of the pilots experiments carried out within this WP.

D2.1 is also contributing to WP3 "Conceptual Framework and Reference Architecture", WP4 "Data Space for Circular and Resilient Manufacturing" and WP5 "AI-enabled Digital Twins for distributed manufacturing" by establishing the methodology for requirements and scenario collection.

1.2 Document Structure

The deliverable includes the following chapters:

Chapter 1, Introduction: this chapter introduces the deliverable and explains its links with other deliverables, tasks and work packages of Circular TwAIn project.

Chapter 2, Methodology: this chapter explains the methodology to be used for the collection and harmonizing of scenarios, needs and requirements.

Chapter 3, Responsibilities: this chapter details the responsibilities associated with each step of the Requirements Engineering Methodology.

Chapter 4, Action Plan: this chapter presents a detailed timeline of all tasks related to the methodology. Deliverables to be developed are also considered.

Chapter 5, Conclusions and Future work: this chapter concludes the deliverable and presents the next steps of work.

2 Methodology

2.1 Description of the Methodology

2.1.1 Requirement Engineering

The Circular TwAIn Requirement Engineering and Verification and Validation (V&V) methodology is based on methodologies which have been adopted for design and development of different types of systems, such as Software Engineering (SE) concerning IT artifacts, Model-Driven Service Engineering Architecture (MDSEA) concerning integration between domain components (IT artifacts, Organization/Human and Physical means) and the ECOGRAI methodology, a method to design and implement Performance Indicator Systems (PIS) for industrial organizations, enabling identification of action means on which decision makers can act to reach their objectives in an integrated way along the system decisional structure.

The approach of the Requirements Engineering and V&V Methodology for Circular TwAIn encompasses a complete requirements life-cycle management method, based on the above-mentioned methodologies, for collecting and harmonizing scenarios, needs and requirements from the different pillars of the project, with the support of specific data structures (namely, the Handbooks) for information sharing along the whole requirements life-cycle.

The BEinCPPS (Business Experiments in Cyber Physical Production Systems) MDSEA methodology is based on a spiral approach.

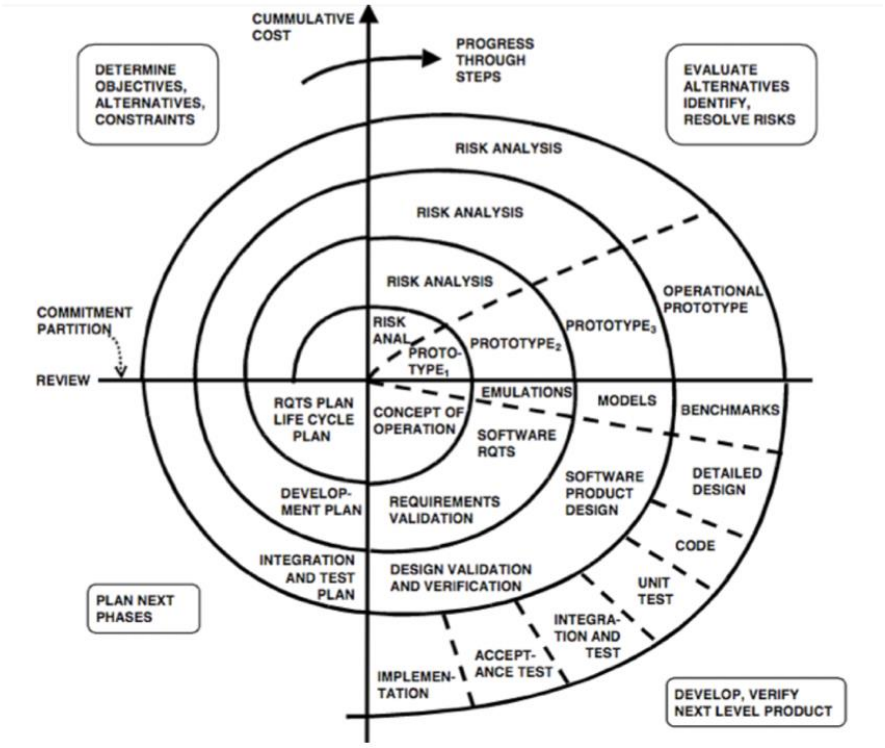

Figure 2-1: Boehm, B. (2000) Spiral Development: Experience, Principles, and Refinements, SPECIAL REPORT CMU/SEI-2000-SR-008

This approach is best used for large and complex projects which involves continuous enhancements. The spiral model enables gradual releases and refinement of a product through each phase of the spiral as well as the ability to build prototypes at each phase.

There are specific activities which are done in one iteration (spiral) where the output is a small prototype of the large system/solution to be deployed. The same activities are then repeated for all the spirals till the entire system/solution is build.

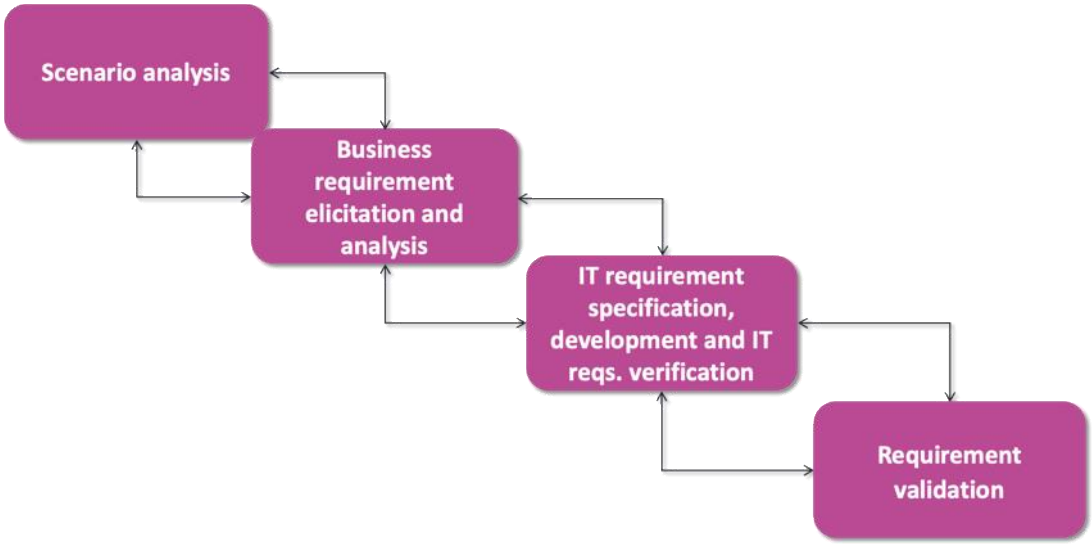

Figure 2-2: Iteration activities

MDSEA is a model-driven methodology for requirements elicitation in manufacturing system that models various kinds of systems and support the development of its major components

according to three domains: Information Technology (IT, i.e., software, device that handle data), Human/Organization (H/O, i.e., people that participates to the process and their organizational structure) and Physical Means (PM, i.e., machine or any physical tool). The methodology distinguishes the business view and technical point of view in products and services and agilizes the software development.

Circular TwAIn is characterized by high complexity in terms of number of interrelated objectives and needs to shape the circular manufacturing environment, which is the field of application of Circular TwAIn project results and outcomes. This makes the process of requirements elicitation and definition of requirements difficult. The Requirement Engineering (RE) methodology that better suits Circular TwAIn features is the spiral approach. It allows the continuous check of all the steps undertaken to understand, plan and test the solutions developed to reach the desired business objectives. Moreover, the use of MDSEA methodology facilitates the transformation of the requirements into specifications and supports the implementation of Circular TwAIn solutions.

Circular TwAIn follows a two iterations approach for its main five WPs (WP2-6), so that at the end of the first iteration at M21 (and at the end of the project-M36) the common project design and development methodology will allow a cross-WP analysis.

The Methodology for the requirements and scenario management, which follows the above-mentioned approach, consists of the following phases:

1. **Scenario Analysis and Business/Technological Requirements, elicitation and analysis**. This phase consists of drawing the as-is and to-be scenarios of the addressed 'system' (experiments) including bottlenecks, objectives and KPIs elicited from the 'system's' users. Then business process modelling and formal modelling (UML, etc.) will be considered as well as the identification of the above mentioned 'requirements', their classification, prioritization and grouping.
2. **Technical Requirement Specification and AI-focused architecture design.** This phase is oriented to the identification of 'technical' requirements of system components covering the business/technological requirements elicited from 'system' users. The chosen components are then composed in the system architectural solution.
3. **Development.** This phase is related to the system's/solution's detailed design and development.
4. **Deployment and verification.** This phase considers the solution's deployment and solution's integration and testing (verification of technical requirements).
5. **Requirement validation, assessment and lessons learned.** This phase will include the assessment of coverage and completion of business/technological requirements and the identification of lessons learned.

Figure 2-3 shows, for each of the five phases of the Circular TwAIn methodology, the main outcomes of Circular TwAIn activities in terms of project deliverables in the first iteration (M1-M21). The same phases will be repeated in the second iteration (M22-M36) with the final versions of the project deliverables as outcomes.

Figure 2-3: Circular TwAIn methodology

2.1.2 Performance Indicator System

The ECOGRAI method is used to support the Requirement Engineering Methodology as it presents a thorough and detailed method to identify a proper Performance Indicator System.

ECOGRAI is a method for designing and implementing Performance Indicator Systems that can be applied on every production function of an industrial organisation. The method has been successfully applied in a number of research projects as a basis for validating their results.

The main *characteristics are:*

- A methodology that can be used with different levels of details and analysis depending on the System complexity
- The result is a coherent set of specification sheets describing each Performance Indicator
- A top-down analysis to break down strategic objectives into tactical and operational objectives
- A participatory approach that involves future users in defining indicators at all levels
- The use of structured analysis tools and graphic supports: GRAI grids, actigrams, etc.
- A coherent distribution of performance indicators covering the various functions and the various decision levels (strategic/tactical/operational)
- The search of a limited number of performance indicators with an original and integrated approach.

In the ECOGRAI approach, three main components must be identified:

- Objectives;
- Action Variables: the actions aiming at reaching the above-mentioned objectives;
- Key Performance Indicators: indicators that evaluate to what extent the objectives are reached by enacting the Action Variables.

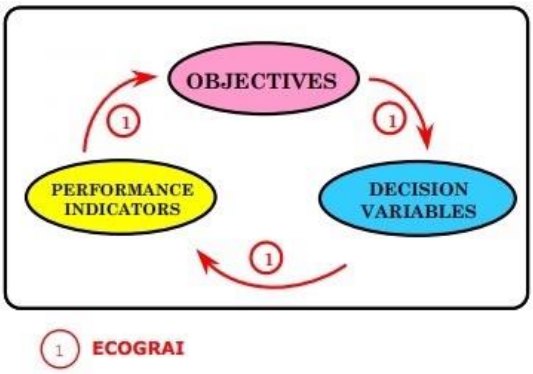

Figure 2-4: ECOGRAI main elements

The three levels (Strategic, Tactical and Operational) of Performance Evaluation are concepts detailed in the GRAI model[3]:

- Strategic level (long term);
- Tactical level (medium term);
- Operational level (short term).

Circular TwAIn will monitor the progress and impact of all the pilots' experiments through Key Performance Indicators: tactical and operational indicators will be designed and implemented through the ECOGRAI approach. Of course, in order to apply in Circular TwAIn the ECOGRAI method an adapted version of the basic model will be built fitting best to the requirements of the project.

2.1.3 Tools

The approach of the Requirements Engineering and V&V Methodology for Circular TwAIn encompasses a complete requirements life-cycle management method, based on the above-mentioned methodologies, for collecting and harmonizing scenarios, needs and requirements from the different pillars of the project, with the support of specific data structures (namely, the Handbooks) for information sharing along the whole requirements life-cycle, as shown in Figure 2-5.

[3] *Doumeingts, Guy & Vallespir, Bruno & Chen, David. (1998). Decisional modelling GRAI grid.*

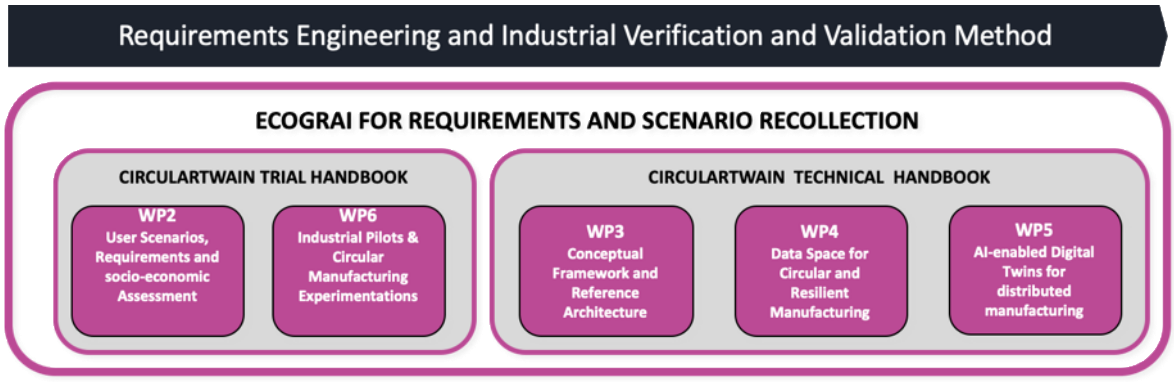

Figure 2-5: Handbooks

The Trial Handbook (THB) is the tool used to monitor the launch and evolution of the pilots' experiments.

The Techno Handbook (TechHB) is meant to be a supporting document that depicts the evolution of the technological offer in a comprehensive and clear way.

2.2 Adoption of the methodology for Industrial Pilots Experiments

2.2.1 Trial Handbook

The Trial Handbook is a confidential "living" document and the central information source for all tasks regarding the pilots, defining in detail the entire process carried out throughout the experiment and the outcomes and results of the activities performed. As such, the objective of this guide is to define, structure, coordinate and collect information regarding the pilots' experiments of the Circular TwAIn project in a standardised manner and assess their impact.

A Trial Handbook will be created for each of the Pilot Use Cases experiments as a "confidential" one-stop-shop. From this repository of scenarios and business processes, proper materials will be extracted for many Circular TwAIn deliverables.

Each experiment will document and be responsible of its own deliverables and of the gathered information, nevertheless to better coordinate and align the development activities inside the experiment participants, the Circular TwAIn Trial Handbook will provide a common structure to gather and present the data. Therefore, the THB will include the following chapters:

- CHAPTER 1: Experiment overview;
- CHAPTER 2: Business Requirements;
- CHAPTER 3: Implementation and results.

By following this structure, the Circular TwAIn Trial Handbook will contribute to the different tasks mainly within WP2 and WP6 (see Figure 2-6).

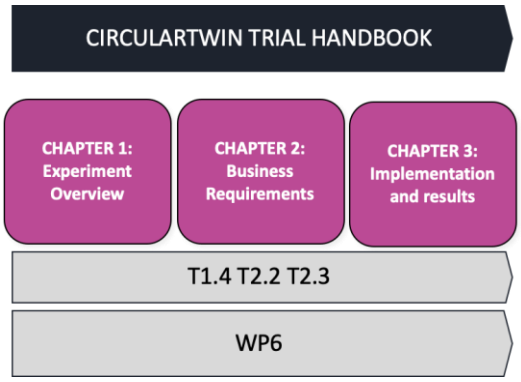

Figure 2-6: Trial Handbook structure

Chapter 1: Experiment Overview

The 1st Chapter "Experiment Overview" of the Trial Handbook will gather all the key overall information of the pilot experiment to allow a comprehensive understanding of the trial, including general information like the trial's site and the involved stakeholders, fully depicting the initial business scenario, with current weaknesses, bottlenecks and objectives, as well as linking the expected business scenario to specific KPIs. In particular, a comprehensive description of the AS-IS and TO-BE business and innovation scenario will be reported in this chapter and then summarized in D2.3 "Digital Transformation pathways assessment and benchmarking - 1st version" due in M18.

The foreseen structure of Chapter 1 is the following:

- General description and motivation;
- Objectives & benefits;
- Experiment's team;
- Experiment's framework:
    - Social framework;
    - Economic framework;
    - Legal and ethical framework.
- As-is Scenario;
- Weaknesses and Bottlenecks;
- To-be Scenario;
- Expected results and KPIs;
- Technical Information (As Is)
    - Trial technologies
    - Existing Platforms
    - Data and Standards

Chapter 2: Business Requirements

In Circular TwAIn, it is crucial to identify and assess the business requirements of each of the experiments. Therefore, the Circular TwAIn Trial Handbook will include a chapter related to Business Requirements. This chapter will capture the business requirements of each experiment in a table (see Table 2-1), including:

- Business process:
  - Business objective;
  - Business impact;
  - Area.
- Business Requirement:
  - Name of Business Requirement
  - Short description;
  - Priority: critical, preferred or optional;
  - Application area;
  - Functional or non-functional requirement.

Table 2-1: Example of a Business Requirement

Req #	Business Requirement	Description	Priority	Application Area	Functional Requirement
00	Name of business requirement	Short description of the business requirement	- Critical - Preferred - Optional	Area of application of Business Requirement	- Functional - Non-Functional

A detailed report of the experiments' business requirements will be included in D2.3 "Digital Transformation pathways assessment and benchmarking - 1st version" due in M18.

Furthermore, this chapter will also include:

- the main Ethical and Legal (EL) requirements linked to the experiment, including the name of the EL requirement, a short description, the priority (critical, preferred or optional), the area of application and the nature (Ethical/Legal). The experiment's leaders will be also required to indicate to which Circular TwAIn technology asset and/or tool the requirement is linked;
- the Ethics Impact Assessment (EPIA) for the experiment concerned, focuses on the ethical procedures and experiment-specific features from the legal and ethical point of view. In this direction, information will be gathered on human involvement, personal data collection and/or processing and Artificial Intelligence development and/or use.

More information on the legal and ethical aspects, on the elicitation and analysis of the related requirements, as well as on the associated responsibilities will be provided in D1.2

"Ethical Analysis, Governance and Guidelines – 1st version" and in D1.4 "Ethical Analysis, Governance and Guidelines – 2nd version", due at M6 and M16 respectively.

Chapter 3: Implementation and results

The 3rd Chapter will be mainly focused on the implementation of the pilot experiment, including an action plan describing the different trial phases, achievements and outcomes also including any barriers faced. In addition, final results and lessons learnt will be described, together with a preliminary exploitation plan for the trial.

- Implementation:
  - Schedule/plan;
  - Implementation/execution;
  - Barriers and difficulties faced.
- Final results and Lessons learnt:
  - Final Experiment and Business Requirements KPIs.
- Exploitation plan.

These contents will be also summarized in D6.2 "Industrial Pilots Implementation and Deployment – 1st version" (M21) and D6.4 "Industrial Pilots Implementation and Deployment - 2nd version" (M36), as well as in the Exploitation Plan of the project and will be updated according to the two iterations of the project.

2.3 Adoption of the methodology for AI, Digital Twins and Data Space for Circularity

WP3 – Conceptual Framework and Reference Architecture, WP4 – Data Space for Circular and Resilient Manufacturing and WP5 – AI-enabled Digital Twins for distributed manufacturing, focus on the development of a comprehensive technological offer for SMEs in order to unlock the innovation potential of a collaborative AI-based intelligence in production based on the use of cognitive digital twins. Based on the use of trustworthy AI techniques, Circular TwAIn will enable human centric sustainable manufacturing, fostering the transition towards Industry 5.0.

The Techno Handbook (TechHB) is a supporting "living" document that depicts the evolution of the technological offerings in a comprehensive and clear way.

2.3.1 Techno Handbook

By respecting this structure, the Circular TwAIn Techno Handbook will contribute to the different tasks within WP3, WP4 and WP5 (see Figure 2-7).

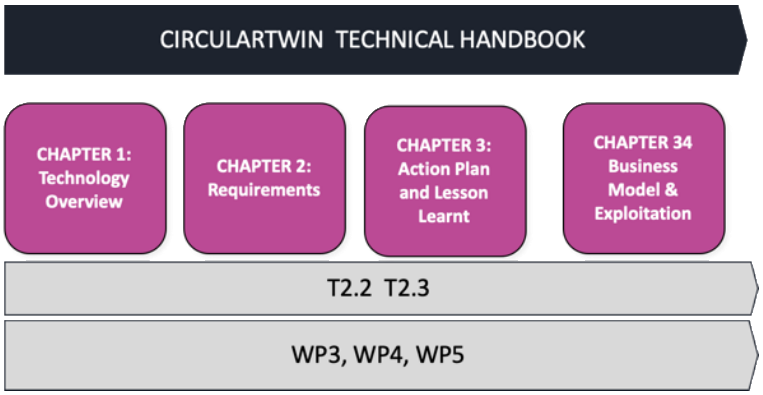

Figure 2-7: Techno Handbook structure

The Circular TwAIn Techno Handbook will provide a common structure to gather and present data. Therefore, the TechHB will at least include the following chapters:

- CHAPTER 1: Technology overview
  - Technology description (Purpose and General Expectations)
  - Backgrounds and State of the Art technologies
- CHAPTER 2: Requirements
  - User Journeys and Grand Scenarios
  - Mapping of Technologies on Requirements
  - Technological Gaps Identification
- CHAPTER 3: Action Plan and Lessons Learnt
  - Development plan
    - First Release
    - Second Release
  - Lessons Learnt
- CHAPTER 4: Business Model and Exploitation
  - Technological Trends
  - Competitors (Direct /Indirect) Analysis
  - Licensing Models (type of license to which the utilization of this technology is subject to)

2.4 Business Requirements and Key Performance Indicators

2.4.1 Business Requirements extraction

The extraction and analysis of business requirements will be done in 4 steps:

1. An Excel spreadsheet template will be generated for the extraction and analysis of the business requirements for each of the pilot experiments. This spreadsheet must be able to gather:
   a. Business requirement;

b. Short description;

c. Priority (critical, preferred or optional);

d. Application area;

e. Functional requirement or not.

2. The business requirements formulated in the handbooks (THB, TechHB) will be extracted and organised in the excel spreadsheets.
3. This first round of extracted requirements will be sent to each contributor in order to provide further insights, corrections, additional business requirements, etc. The spreadsheet will be then delivered back to the responsible partner of each of the cases.
4. The received document will be analysed and updated in the handbooks.

2.4.2 Formulation of KPIs

Circular TwAIn will monitor the progress and impact of all the pilot experiments through Key Performance Indicators. In the Trial Handbook and Tech Handbook, each contributor will design and implement their strategical, tactical and operational indicators through the ECOGRAI approach.

The following steps will be followed in the design of the pilot KPIs:

1. Defining Objectives at:
    a. Strategic level: pilot experiment level;
    b. Tactical level: phase objectives;
    c. Operational level: task objectives.
2. Defining Action variables for each level;
3. Define KPIs for each Action;
4. Define time horizon and period for each KPI.

Table 2-2. Relation between monitoring levels and ECOGRAI elements

Level	Objectives (step 1)	Actions (step 2)	KPIs (step 3)
Strategic	Pilot experiment level objectives	Conclude all pilot experiment activities	For each objective/action
Tactical	Phase level objectives	Conclude all phase activities	For each objective/action
Operational	Task level objectives	Conclude all task activities	For each objective/action

Extraction and analysis of KPIs

The extraction and analysis of KPIs will be done in 4 steps:

1. An Excel spreadsheet template will be generated for the extraction and analysis of the KPIs for each of the cases. This spreadsheet must be able to gather:

   a. Description: a brief description of the KPI;
   b. As-is KPIs: measured before starting the pilot experiment;
   c. To-be KPIs: the objective they expect to reach at the end of the pilot experiment;
   d. Final KPIs: measured at the end of the pilot experiments.
2. The KPIs formulated in the handbooks will be extracted and organised in the excel spreadsheet.
3. The participants will provide the final KPIs through the handbooks and submit it to the responsible partner.
4. The final KPIs will be extracted from the handbooks and compared against the initial KPIs and the objectives.

3 Responsibilities

This section defines the responsibilities of the partner(s) involved in each action/task within the methodology.

3.1 Trial Handbook

The Circular TwAIn THB will be designed by WP2 and WP6 leaders, and possible other involved partners, and they will be responsible of distributing the final version to all the experiments. They will also be in charge of the quality assurance of the THB, with the support of the Experiments Groups leaders, controlling the quality of the information provided and requesting all the needed clarifications, corrections, etc. to the contributors of the documents. For this purpose, a quality assurance procedure will be carried out after each submission. This will enable the creation of a high-quality standard document for each of the experiments, which will lead to high quality identification, description of scenarios and final assessment of the Industrial and Technological pilots.

In particular, each Trial leader, in collaboration with the end user representatives and the IT provider representatives, will be responsible to complete the information requested in the different THB chapters. The experiments Group Leaders, in collaboration with WP2 and WP6 task leaders, will be responsible for the Quality Assurance of the THB in their group. Then, WP2 and WP6 Leaders will be responsible for the final THB evaluation.

The Circular TwAIn Trial Handbook will be distributed to all the experiment participants and will include the corresponding instructions addressing the way in which it needs to be correctly completed.

Thus, WP2 and WP6 leaders will be responsible for the final submission of the THB, while Experiments Group Leaders will be the interface to collect feedback from the specific task leaders' experts and to share and include the required information with the experiments under their group.

In particular, T2.2 and T2.3 will be responsible for the creation of the scenarios, requirements and Performance Indicators for the AI solutions and industrial experiments sections (documented in D2.3), T1.4 "Ethics Assessment and Governance" will be responsible for the revision of legal and ethical contents, while WP6 will be responsible for the revision of the implementation and results contents.

3.2 Techno Handbook

The Circular TwAIn Techno Handbook will be designed by WP3, WP4 and WP5 together with WP2 task leaders and possible other involved partners, and they will be responsible of distributing the final version. They will also be in charge of the quality assurance of the Techno Handbook. They will control the quality of the information provided and will request all the needed clarifications, corrections, etc. to the contributors of the documents. For this purpose, a quality assurance procedure will be carried out after each submission. This will enable the creation of a high-quality standard document for each of the experiments, which will lead to high quality identification, description of scenarios and final assessment of the Industrial and Technological pilots.

The Techno Handbook will be composed of four chapters and each of them must be submitted within the deadline (set by WP2, WP3, WP4 and WP5) to the responsible partner, also established by WP2, WP3, WP4 and WP5.

3.3 Business Requirements and KPIs

Business Requirements and KPIs will play an important role in all the 4 pillars of the Circular TwAIn project.

In the case of experiments, the experiments (WP6) will be responsible of creating specific KPIs and providing as-is (baseline), to-be and final values. They will also be in charge of providing the Business Requirements. This information will be provided through the Circular TwAIn Trial Handbook. T2.2 and T2.3 will be responsible of creating the common KPIs for all the pilot experiments. These common KPIs will enable the assessment of the evolution of all the experiments within a harmonised framework.

Regarding AI Platforms and Data Spaces, developing and providing KPIs and Business Requirements will be in the hands of WP3, WP4 and WP5. This information will be provided through the Techno Handbook.

In each of the cases, T2.3 will be in charge of the extraction procedure for the Trial Handbook and WP3, WP4 and WP5 for the Techno Handbook:

1. Extracting the KPIs (as-is and to-be) from the corresponding Handbook;
2. Extracting and formalising the Business Requirements from the corresponding Handbook;
3. Extracting the Final KPIs from the corresponding Handbook;
4. Analysing the KPIs and drawing up conclusions.

4 Action Plan

A summary table with the responsibilities to implement the methodology is available in this section:

Table 4-1. Relation Plan of Activities

Activity	Responsible	Date
Scenarios and Expectations: Trial Handbook (WP2 and WP6)		
Design and distribution	WP2 and WP6	M4
Contribution: Chapter 1- Experiment Overview	WP6	M5
Quality assurance review	WP2 and WP6	M6
Contribution: Chapter 2- Business Requirements	WP6	M7
Quality assurance review	WP2 and WP6	M8
D2.2 User Scenarios, Requirements and Performance Indicators - 1st version	T2.2-T2.3	M9
D6.1 Methodology and Tools for Industrial Pilots coordination - 1st version	WP6	M9
Contribution: Chapter 3 - Implementation and results	WP6	M20
Quality assurance review	WP2 and WP6	M21
D6.2 Industrial Pilots Implementation and Deployment - 1st version	WP6	M21
Revision and update: Chapter 1- Experiment Overview	WP2 and WP3	M21
Quality assurance review	WP2 and WP6	M22
Revision and update: Chapter 2- Business Requirements	WP2 and WP6	M23
Quality assurance review	WP2 and WP6	M24
D2.5 User Scenarios, Requirements and Performance Indicators - 2nd version	T2.2-T2.3	M24
D6.3 Methodology and Tools for Industrial Pilots coordination – 2nd version	WP6	M27
Contribution: Chapter 3 - Implementation and results	WP6	M35
Quality assurance review	WP2 and WP6	M36
D6.4 Industrial Pilots Implementation and Deployment – 2ndt version	WP6	M36
Business Requirements and Key Performance Indicators for pilot experiments (WP2 and WP6)		
Design of common pilot experiment KPIs	T2.2-T2.3	M4
Design and provision of Experiment As-is and to-be KPIs	WP6, WP3, WP4, WP5	M5
Extraction of Experiment As-is and to-be KPIs	T2.2-T2.3, WP3, WP4, WP5	M6

Design and provision of Business Requirements	WP6, WP3, WP4, WP5	M7
Extraction and analysis of Business Requirements	T2.2-T2.3, WP3, WP4, WP5	M9
Provision of Final KPIs	WP6, WP3, WP4, WP5	M34
Extraction and analysis of Final KPIs	T2.2-T2.3	M36
Requirements and scenario recollection for Data Space and Digital TwAIns: Techno Handbook (WP2 and WP3, WP4, WP5)		
Design and distribution	WP2 and WP3	M4
Contribution: Chapter 1- Technology overview	WP3	M5
Quality assurance review	WP2 and WP3	M6
Contribution: Chapter 2 - Requirements	WP3	M7
Quality assurance review	WP2 and WP3	M8
D3.1 - Conceptual Framework and Reference Architecture - 1st version	WP3	M9
Contribution: Chapter 3 & 4	WP3, WP4, WP5	M10
Quality assurance review	WP2 and WP3	M11
D3.2 - Data Space and Digital TwAIns Design - 1st version	WP3	M12
D3.3 - Data Space and AI Toolkit Reference Implementations - 1st version	WP3	M12
Revision and update: Chapter 1	WP3	M22
Quality assurance review	WP2 and WP3	M23
Revision and update n: Chapter 2	WP3	M24
Contribution: Chapter 3 & 4	WP3, WP4, WP5	M25
Quality assurance review	WP2 and WP3	M26
D3.4 - Conceptual Framework and Reference Architecture – 2nd version	WP3	M27
D3.2 - Data Space and Digital TwAIns Design – 2nd version	WP3	M27
D3.3 - Data Space and AI Toolkit Reference Implementations - 1st version	WP3	M12

5 Conclusions and Future Work

D2.1 “Circular TwAIn Requirements Engineering Methodology” defines the methodology for Requirements Engineering and Performance indicators assessment, in order to support the constant verification and validation of Performance Indicators.

The Requirements Engineering and Industrial Verification and Validation Method is based on the ECOGRAI method, and enables the collection and harmonization of scenarios, needs and requirements from the four different pillars of the project.

The ECOGRAI approach is complemented with the use of handbooks for each of the 4 pillars of Circular TwAIn:

- The Trial Handbook will be used to monitor the launch and evolution of Circular TwAIn pilot experiments. It is the central information source for all tasks regarding the pilots, defining in detail the entire process carried out throughout the experiment, the outcomes and the results of the activities performed.
- The Techno Handbook will be used as a one-stop-shop to collect all the information regarding the development of the technological activities of the project.

The methodology has been established within a concrete timeline and action plan. This timeline enables the correct development and execution of the different activities within Circular TwAIn and allows the design, drafting and submission of the deliverables according to the schedule.

The methodology and action plan reported in this documented will be revised in D2.4 “Requirements Engineering Methodology - 2nd version” due in M21.

References

[1] Project: 101058585 — Circular TwAIn — HORIZON-CL4-2021-TWIN-TRANSITION-01: Description of the action (DoA) Part A Part B

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101058585