ONTO-DESIDE GA NUMBER: 101058682

ONTO-DESIDE

DELIVERABLE

Project requirements specification and research methodology – v2

Deliverable number	D2.2
Deliverable name	Project requirements specification and research methodology
Work package	WP2
Lead partner	RS
Contributing partners	LIU, IMEC, CON, POS, CIRC, UHAM, FAS, LIND, TEXON, REIA
Deadline	2024-01-31
Dissemination level	Public
Date	2024-01-30

Funded by
the European Union

PROJECT INFORMATION

Project summary

Circular economy aims at reducing value loss and avoiding waste, by circulating materials or product parts before they become waste. Today, lack of support for sharing data in a secure, quality assured, and automated way is one of the main obstacles that industry actors point to when creating new circular value networks. Together with using different terminologies and not having explicit definitions of the concepts that appear in data, this makes it very difficult to create new ecosystems of actors in Europe today. This project will address the core challenges of making decentralized data and information understandable and usable for humans as well as machines. The project will leverage open standards for semantic data interoperability in establishing a shared vocabulary (ontology network) for data documentation, as well as a decentralized digital platform that enables collaboration in a secure and privacy-preserving manner.

The project addresses several open research problems, including the development of ontologies that need to model a wide range of different materials and products, not only providing vertical interoperability but also horizontal interoperability, for cross-industry value networks. As well as transdisciplinary research on methods to find, analyze and assess new circular value chain configurations opened by considering resource, information, value and energy flows as an integral part of the same complex system. Three industry use cases, from radically different industry domains, act as drivers for the research and development activities, as well as test beds and demonstrators for the cross-industry applicability of the results. The developed solutions will allow for automation of planning, management, and execution of circular value networks, at a European scale, and beyond. The project thereby supports acceleration of the digital and green transitions, automating the discovery and formation of new collaborations in the circular economy.

Project start date and duration

1st of June 2022, 36 months

Project consortium

No	Partner	Abbreviation	Country
1	Linköping University	LIU	Sweden
2	Interuniversitair Micro-Electronica Centrum	IMEC	Belgium
3	Concular Ug Haftungsbeschrankt	CON	Germany
4	+Impakt Luxembourg Sarl	POS	Luxembourg
5	Circularise Bv	CIRC	The Netherlands
6	Universitaet Hamburg	UHAM	Germany
7	Circular.Fashion Ug (Haftungsbeschrankt)	FAS	Germany
8	Lindner Group Kg	LIN	Germany
9	Ragn-Sells Recycling Ab	RS	Sweden
10	Texon Italia Srl	TEXON	Italy
11	Rare Earths Industry Association	REIA	Belgium

Document reference

Project acronym	Onto-DESIDE			
Programme	Horizon Europe			
Grant agreement number	101058682			
Project URL	https://ontodeside.eu/			
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Deliverable name	Project requirements specification and research methodology - v.2			
Deliverable number	D2.2			
Deliverable version	V1.9			
Deliverable nature	Report			
Dissemination level	Public			
Due date	M6			
Delivery date	31/01/2024			
Keywords	Requirements, Ontology, Open Circularity platform, user stories			

Document change log

Version	Date	Description	Authors	Checked by
0.1	05.10.2022	Initial draft	Mikael Lindecrantz	Olaf Hartig
0.2	12.10.2022	Clarification of objectives	Mikael Lindecrantz	
0.3	14.10.2022	Clarification of research methodology	Mikael Lindecrantz	
0.4	20.10.2022	Added section on non-functional requirements	Mikael Lindecrantz	
0.5	09.11.2022	Added user stories for the textiles use-case	Mikael Lindecrantz Logan Moray Thibaut Wautelet	
0.6	11.11.2022	Added draft user stories for Electronics	Mikael Lindecrantz	
0.7	16.11.2022	Added user stories for the construction use-case	Mikael Lindecrantz Lore Ameel	
0.8	17.11.2022	Added part on generalization and concluding comments	Mikael Lindecrantz	
0.9	22.11.2022	Review		Svjetlana Stekovic
1.0	28.11.2022	Update after review	Mikael Lindecrantz	
1.1	29.11.2022	Updated electronics user stories and fixed formatting	Mikael Lindecrantz, Teresa Oberhauser	
1.2	20.12.2023	Input on textile use case requirements	Daryna Panasiuk	
1.3	08.01.2024	Input on circularity thinking and WP5 requirements and process	Charis Lüdtke	
1.4	08.01.2024	Input on platform requirements	Els Devleeschauwer Ben De Meester	
1.5	10.01.2024	Input on construction use case requirements	Caroline Braus	
1.6	12.01.2024	Input on electronics use case requirements	Maria Alejandra Leon Aguirre	

1.7	25.01.2024	Circularity requirements chapter introduction.	Charis Lüdtke	
1.7	25.01.2024	Internal project review	Robin Keskisärkkä	
1.8	26.01.2024	Update according to internal review comments	Mikael Lindecrantz	
1.9	30.01.2024	Changed prio on TUS07	Daryna Panasiuk	
2.0	31.01.2024	Design changes	Mikael Lindecrantz	

Document approval

Version	Date	Name	Role in the project	Beneficiary
0.9	22.11.2022	Svjetlana Stekovic	Internal reviewer	LIU
1.0	29.11.2022	Eva Blomqvist	PC	LIU

Table of Content

Abbreviations

Abbreviation	Explanation
GDPR	General Data Protection Regulation
PCDS	Product Circularity Data Sheet
FAIR	Findability, Accessibility, Interoperability, and Reuse of digital assets

1 Introduction

The Onto-DESIDE project applies an iterative methodology, where research and innovation are driven by industry needs identified in a set of industry use cases, and solutions become more mature with each iteration. Three project use cases, representing three distinct industry sectors (construction industry, electronics and appliances, and textile industry), will contribute to identify the needs and technical requirements of the Open Circularity Platform, but also act as test beds and evaluation scenarios for the novel solutions produced.

In this way, the project aims to show that results produced are concrete enough to solve specific problems, i.e., in three specific use case domains, but also that the Open Circularity Platform has potential to be widely applied. Thus, it constitutes a cross-industry solution for ontology-based data documentation that works together with other value network flows, as well as being connected to several European initiatives, such as the Industry Commons and its Onto Commons project, the EOSC and European Data Spaces.

The project consists of three iterations, where each technical Work Package (WP) contributes to all the iterations. The WP dependencies are illustrated in **Fel! Hittar inte referenskälla.** where the details of the first project iteration are shown. The duration of the first project iteration is Month (M) 1-18, while the second and third iterations are shorter, encompassing M19-27 and M28-36, respectively. Each iteration ends with collection of feedback from the industry use cases, which is analysed and reported in a WP6 deliverable (i.e., evaluation report).

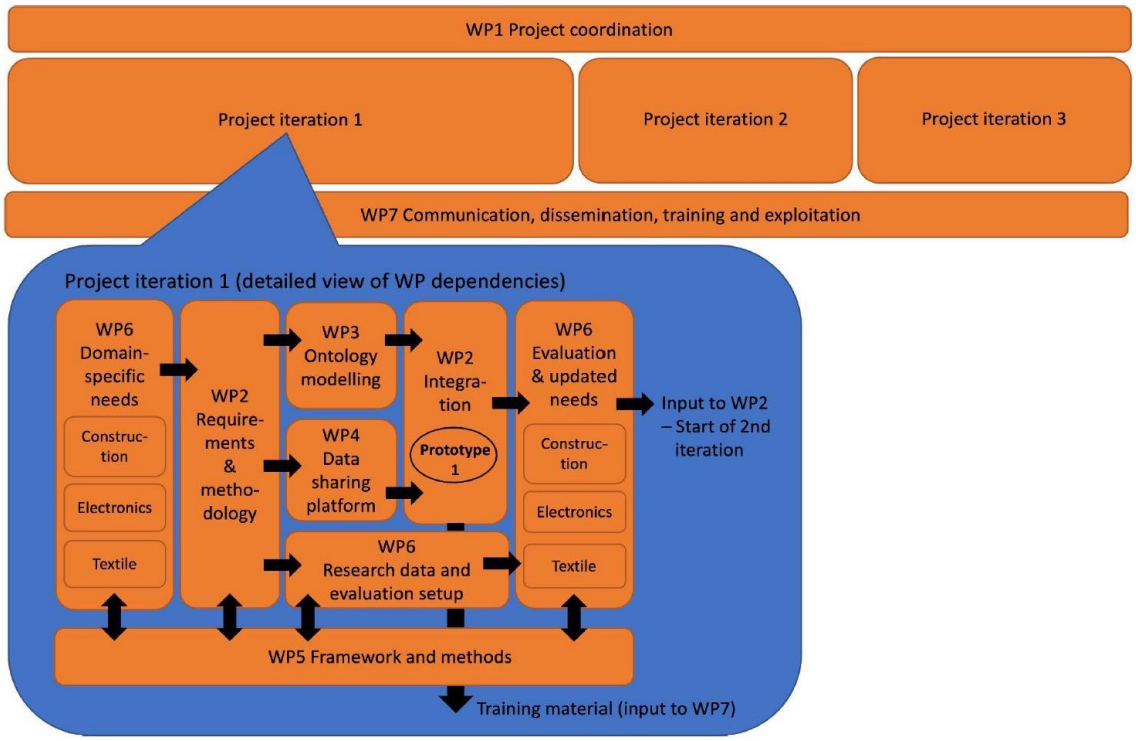

Figure 1: Project outline and dependencies between work packages.

1.1 Objectives and research methodology

1.1.1 Objectives

Work package 2 (WP2) will ensure the generalization over the three use case domains as described in industry use cases in WP6 ensuring that the project treats a set of requirements that covers the needs of all the three use cases, but that are general enough to also apply in other industry domains.

The WP2 will also be responsible for setting up the overall research and development methodology applied in the project, as well as performing the technical integration of software components, and protocols for data sharing, to ensure that a coherent technology stack for ontology-based data documentation is delivered at the end of the project.

Further, the WP2 is responsible for preparing a standardization plan for the results produced in the project and initiating standardization efforts according to that plan.

1.1.2 Research methodology

The concrete research process of the Onto-DESIDE project has been divided into three iterations, each divided in 3 steps (cf. Figure 2):

- Step 1: analysis of needs and elicitation of requirements
- Step 2: research and technical development, including solution integration into a coherent prototype
- Step 3: use case-based observation and evaluation, providing feedback as well as revised and extended needs and requirements to start off the next iteration.

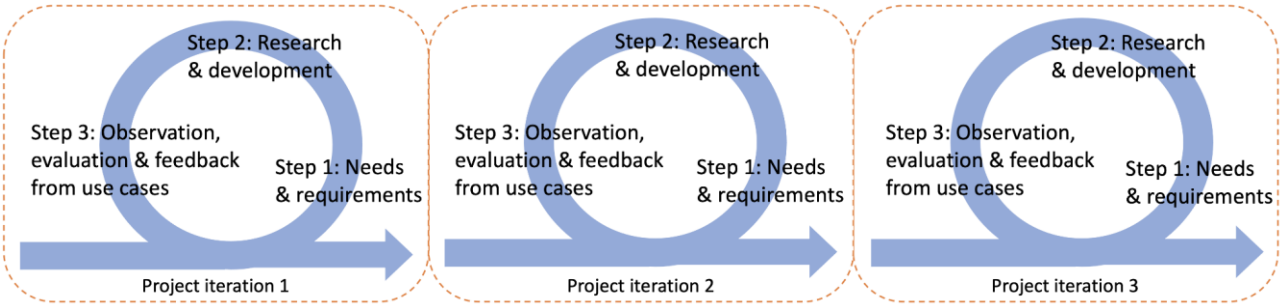

Figure 2: The Onto-DESIDE research process, divided into 3 iterations, each consists of three steps.

Specifically, for WP2, the focus is on transforming the use case definitions of WP6 into technical requirements that will be the base for further work in WP3 and WP4. For this, practices from the software engineering domain will be used to capture and detail functional requirements in the form of user stories, (Figure 3).

Additionally, non-functional requirements, such as performance and security that are not directly linked to specific functionality that users need to fulfil their tasks, will be derived from the project specification and included as a list in this deliverable.

FIGURE 3 DIAGRAM VISUALIZING THE WORKFLOW OF WP2 AND THE RELATED ARTIFACTS

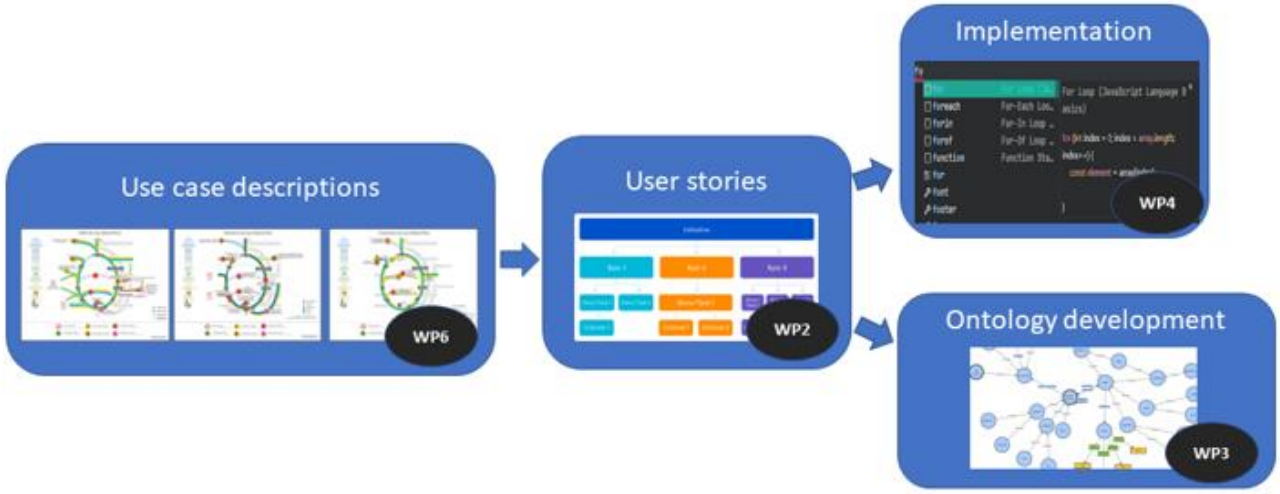

Figure 3: Overview of the workflow between work packages.

User stories for capturing functional requirements

A user story is an informal, general explanation of an action that needs to be taken to achieve a certain result. User stories are written from the perspective of the end user. Its purpose is to articulate how the user plans achieving a certain goal or task.

In this project, the user stories will be defined and based on the detailed use cases produced in WP6. During this process we also consider generalization in the sense of user stories that would be meaningful for all the use cases. These user stories are then labelled epics, where the term epics is reused from the practice of agile software development[1], as to point out that they support more than one use case. These epics will be listed separately in further revisions of this deliverable.

The numbering system used will reference the use case (abbreviated in two letters), then the number of the user story, lastly the textual name of the story heading. The layout of a user story would be text represented in a document as illustrated in Figure 4.

TUS1: Access to production data
As a: Fiber Supplier **I want:** To access data about processes in which the waste I use in combination with my raw material have been produced **So that:** I can assure the quality and the sustainability of the material (traceability) **Additional context information** I introduce recycled fibers (from post-industrial or pre-consumer uses) to my raw material to improve the sustainability of my textile fibers (% of recycled content) **Data needs:** - Process generating waste - Recycling process used - Product characteristics

Figure 4: Example of a user story layout

[1] https://www.agilealliance.org/glossary/epic/

As a guidance for writing a user story the following template is used:

- As a (**who** wants to accomplish something)
- I want to (**what** they want to accomplish)
- So that (**why** they want to accomplish that action, item, etc.)

Additionally, each user story will follow a use case specific numbering scheme where the first letter is the use case, followed by the number of the specific user story. As an example, the first user story in the construction use case would be C1, followed by C2, etc. Also, where possible, a short extra context description will be given as well as generic pointers to what type of data are required (see example template above).

Circularity requirements
The development of methods to find, analyse, and assess new value chain configurations is done within WP5. WP5 is using and extending tools from Circularity Thinking (developed by Blomsma and colleagues) for the accelerated development of systemic circular solutions. To evaluate the circularity methodology throughout the project, requirements pertaining to circularity are listed as part of this deliverable. See chapter 3, circularity requirements for further detail.

1.2 Tasks and deliverables

WP2 is led by RS and is divided into four tasks, each related to the objectives of the work package. These tasks are outlined below:

- T2.1 - Requirements - lead: RS - participants: all project partners
- T2.2 - Integrated methodology framework - lead: UHAM - participants: LIU, IMEC, RS
- T2.3 - Technical integration - lead: RS - participants: LIU, IMEC, CIRC
- T2.4 - Standardisation - lead: POS - participants: LIU, IMEC, RS

Three deliverables are to be produced for WP2 during the project:

- D2.1 Project requirements specification and research methodology (v1 M6, v2 M20, v3 M29)
- D2.4 Software and protocol releases (v1 M12, v2 M24, v3 M33)
- D2.7 Standardization plan (v1 M18, v2 M30)

This document constitutes the report for deliverable D2.2 and aims to gather industry needs and transforming them into ontological and technical requirements, generalising from all three use cases. It also includes collecting legal, ethical, security and privacy requirements and generalising from all three use cases as they are documented in WP6.

2 Functional requirements

The following chapter outline the functional requirements as captured in user stories. Use case specific user stories are presented per use case. Generalised user stories are broken out as epics and grouped together separately.

To better prioritize development of the ontology and the open circularity platform some user stories will be marked as prioritized or, on the other end of the scale, less important. In dialog with the respective use case leads, these stories represent functionality in the envisioned platform that are more important than other features. This prioritization is intended to be used as guidance for WP3 and WP4 but not to be the sole truth, given the holistic picture of implementing certain user stories, WP3 and WP4 are free to do their own prioritization that makes the most sense from an implementation perspective.

User stories that are important will be denoted with a green arrow:

User stories that are less important will be denoted with a grey arrow:

This prioritization will not be done for all the user stories in D2.2, this initial prioritization has been done based on for what stories each use case could agree on a prioritization. This work will continue.

2.1 Construction use-case user stories

Based on the work done using the Circularity Compass in D6.1, several shortcomings have been identified across all phases of the product life cycle of the selected construction component, where information and understanding on handling of the component are lacking. Based on these shortcomings, needs have been identified corresponding to the product lifecycle. Additionally, a set of initial stakeholder types have been identified. These stakeholder types will be used as the subject actors of the defined user stories for this use case.

Actors:

- **Building owner**
- **Manufacturers**
- **Dismantler**
- **Tenderer**
- **Recycler**
- **Deconstruction company**
- **Planner**
- **Marketplace**

2.1.1 CUS1: End of life scenarios

As a: Building owner

I want:
I want to know which are the different end-of-life scenarios for building materials.

So that:
I can decide on how the material should be handled.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Detailed product information and information on the state of the product.

2.1.2 CUS2: Material business case

As a: Building owner

I want:
I want to obtain economic and environmental costs of different end-of-life scenarios for building material.

So that:
I can make financially and environmentally sound decisions on how the material should be handled.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Detailed product information and information on the state of the product. Additionally, data related to environmental impact and lifecycle of the product.

2.1.3 CUS3: Inventory

As a: Manufacturer

I want:
I want to obtain information on quantities and locations of my products that will be dismantled.

So that:
I can organize take-back-systems, refurbishment or reselling for these products.

Additional context information
Timings are relevant in this context, as to be able to plan for taking back at the right time and with optimal logistics. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Location and quantity.

2.1.4 CUS4: Rest material from production

As a: Manufacturer

I want:

I want to find out if the rest material from my production could be used in other production processes.

So that:
I can find other financial and environmentally sound ways to offset the material.

Additional context information
For this to be practical, some type of matching functionality would be needed where one could enter criteria and do a search on matching offset paths. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Data to correlate with material data of the rest materials produced in production.

2.1.5 CUS5: Cost

As a: Manufacturer

I want:
I want to know the costs of dismantling and refurbishing my products.

So that:
I can be able to make financially sound decisions on how to design a take-back system.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Product data. Tender cost for the dismantling and/or refurbishment.

2.1.6 CUS6: Market demand

As a: Manufacturer

I want:
I want to know the market demand for a refurbished product.

So that:
I can be able to make financially sound decisions on how to design a take-back system.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
To be detailed in later versions of the deliverable.

2.1.7 CUS7: Dismantling

As a: Dismantler

I want:

I want to find out where there are needs of dismantling of products for a certain building and what these products are.

So that:
I can go to the building and dismantle the products in the correct way.

Additional context information
The actions taken and the information needs are to be seen from the perspective of a dismantler. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Product and location data, as well as information on dismantling and handling of the product.

2.1.8 CUS8: Tender

As a: Tenderer

I want:
I want to retrieve product information from the manufacturer.

So that:
I can integrate a dismantling method description in the deconstruction tender.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Detailed product information.

2.1.9 CUS9: Recycling

As a: Recycler

I want:
I want to be informed on buildings where deconstruction and retrieval of certain secondary raw materials is planned and for what products it is planned.

So that:
I can go to the building and handle the products and materials in the correct way.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Product data as well as location data.

2.1.10 CUS10: Deconstruction

As a: Deconstruction company

I want:
I want to be informed on buildings where the deconstruction is planned and for what products.

So that:
I can go to the building and perform the deconstruction in the correct way.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
To be detailed in later versions of the deliverable.

2.1.11 CUS11: Marketplace

As a: Marketplace

I want:
I want to retrieve product information such as composition, dimensions, quantities, and pricing.

So that:
I can market and sell these products.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Detailed product information as well as quantities, location, and pricing.

2.1.12 CUS12: Reuse

As a: Planner

I want:
I want to retrieve product information such as measurements, qualities, and quantities.

So that:
I can propose the building material when planning for a new building.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
Detailed product information as well as quantities, location.

2.1.13 CUS13: Planning

As a: Manufacturer, Dismantler, Tenderer, Recycler, Deconstruction company, Planner, Marketplace

I want:
I want to retrieve product information such as measurements, composition, qualities, quantities, and location. I also need to be able to access the process and handling information that are related to these products.

So that:
I can offer the correct services and handling at the correct cost and at the correct time and location.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
To be detailed in later versions of the deliverable.

2.2 Electronics and appliances use-case user stories

Based on the work done using the Circularity Compass in D6.1, several shortcomings have been identified across all phases of the product life cycle where information and understanding on handling are lacking. Based on these shortcomings, a set of initial stakeholder types have been identified. These stakeholder types will be used as the subject actors of the defined user stories for this use case.

Actors:

- **Suppliers** (material suppliers)
- **Manufacturers** (part, component, and product)
- **Brand** (can be active in the production phase i.e., direct manufacturing; can be also active in the retailing phase i.e., direct selling)
- **Users**
- **Recycler**
- **Sorter**

2.2.1 EUS1: Provenance/ quality and sustainability of raw materials

As a: Supplier

I want:
To be able to proof the quality characteristics of the material I supply to the Brand, End-user, and Legislator

So that:
I can assure the quality and the sustainability of the material (traceability) and a) unlock a higher price category for my certified high-quality material and b) secure my continuous contract with the customer.

Additional context information

As a material supplier, it is often almost impossible to know which final product my material ends up in, let alone proof it. This is, among others since supplier's identity is secret as intermediaries fear that their suppliers and customers cut them out of the deal by interacting directly. With a traceability system I want to be able to proof the quality characteristics assessed at my stage of the supply chain to the brand and end user, several steps later. This also includes the compliance with legislation and the sustainability of the material and its contribution to circularity. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Recycled material content
- Product Carbon Footprint data of material provided and production process
- Regulatory frameworks

2.2.2 EUS2: Production process

As a: Manufacturer

I want:
To understand the origin of the materials and the production processes

So that:
I can understand what kind of materials and components my product contains to a) mitigate supply risks, b) improve my supply chain, c) fulfilling regulations on e.g., digital product passport and the supply chain act in the future.

Additional context information
Supply chain stakeholders are currently unknown to the OEM. However, the increasing need for material data also requires being able to retrieve the data from the supply chain step where the data originates, the supplier who can proof validity of data. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Provenance
- Material composition
- Stakeholder types in the supply chain
- Location of production

2.2.3 EUS3: Quality and compliance

As a: Manufacturer/ Brand

I want:
To assess the sustainability performance of my production.

So that:
I can assure a) the quality of my product b) the compliance of my product with legislation and standards. I can assure that my product is sustainable, entails sustainable materials. I can calculate my life cycle assessment and product carbon footprint.

Additional context information
Manufacturers are under increase pressure to meet sustainability targets and regulation. They require a system that allows them to proof that they are sourcing sustainability and

meeting quality standards (e.g., the Made in XXXX, critical raw materials sourced sustainably). Furthermore, many manufacturers have made big claims to move towards carbon neutrality. To achieve that, they need to a) understand what their current sustainability parameters are, b) how to improve them and c) how to proof the sustainability to their customers. Most big companies cannot assess the sustainability of their product and supply chain, right now, without employing an external consultancy to conduct expensive research. What is required is a system that provides access to the knowledge and data that is available dispersed across different stakeholders of the supply chain. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Compliance schemes (e.g., REACH)
- Monitored materials (e.g. mercury, flame retardants, CFCs…)
- Recycled material content
- LCA data of each supply chain stakeholder (where available)
- Sustainability of production processes
- Carbon accounting data

2.2.4 EUS4: Product usage

As a: User

I want:
To find information on how sustainable my product is and how to recycle or refurbish my product.

So that:
I can ensure that I get the most optimal performance in all phases of the products lifecycle. I can reduce my carbon footprint. I know that the quality I paid for (more sustainable product) is there.

Additional context information
To avoid greenwashing and encourage users to buy more sustainable and circular products, the communication of sustainability parameters is crucial. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Dismantling/ repair information
- Material composition
- Certifications of sustainability (e.g., recycled material certificate).
- Quality criteria e.g., made in EU, sustainably sourced critical materials.

2.2.5 EUS5: Product composition

As a: Recycler

I want:
To understand the composition of the product.

So that:
I can recycle it efficiently and securely.

Additional context information

Information on hazardous substances and safe handling are important in this context but they are not always easy to get hold of. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Dismantling information
- Chemical composition
- Hazardous substances contained
- Degradation level of materials

2.2.6 EUS6: Safety

As a: Recycler

I want:
To find out if a product contains hazardous materials.

So that:
I can recycle it in a safe and efficient way.

Additional context information
This pertains to more to handling of the product so that it does not cause human harm and to what extent known effects on the environment there are. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Dismantling guidelines
- Compliance schemes
- Hazardous substances

2.3 Textiles use-case user stories

Based on the work done using the Circularity Compass in D6.1, several shortcomings have been identified across all phases of the product life cycle where information and understanding on handling are lacking. Based on these shortcomings, needs have been identified that correspond to the product lifecycle. Additionally, a set of initial stakeholder types have been identified. These stakeholder types will be used as the subject actors of the defined user stories for this use case.

Actors:

- **Suppliers** (fibre suppliers, other components suppliers)
- **Manufacturers** (fibre manufacturers, shoe manufacturers, product assembly)
- **Brand** (can be active in the production phase i.e., direct manufacturing, can be also active in the retailing phase i.e., direct selling)
- **Retailer**
- **Users**
- **Collectors/Sorters**
- **Recycler**

2.3.1 TUS1: Access to production data

As a: Fiber Supplier

I want:
a possibility to display the material content of my fibers requested by my customers.

So that:
I can assure all information on my fibers can be easily accessed by my customers.

Additional context information
I receive frequent requests from my customers to provide information on the type of fibers, their origin, the recycled content as well as proof related to this information. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Category of fiber (fabric, yarn, trim, etc.)
- Type of material (Specific type of a material depending on the chosen category of a fiber)
- Country of origin of raw material
- Certificates
- Colors
- Any recycling recommendation
- (Biodegradability certificate:
    - REACH compliant = Does the product comply with REACH? Compliance with chemical regulations or standards can determine recycling cycle.
    - AFIRM compliant = Does the product comply with AFIRM? Compliance with chemical regulations or standards can determine.

Functional requirements:

- A form where I can fill in all data clustered by product, variation, material, assembly e.g., as dropdowns to select or free text fields.
- Save functionality.
- Upload functionality for certificates
- Input for certificate numbers
- Upload functionality for images of fiber

2.3.2 TUS2: Access to editable and updatable content

As a: Fiber Supplier and Transformation actor

I want:
A possibility to edit and update the material content of my fibers/properties of my product displayed on the platform.

So that:
The information that my customers accessed is always up to date.

Additional context information
The input materials to my production process may vary due to e.g., change of suppliers. This has an impact on the chemical composition of the fibers, without impacting the overall performance of the fibers or of my product.

Data needs:

Functional requirements:

- Edit possibility to e.g., upload newly required certificates or new colors

2.3.3 TUS3: Integrated product data

As a: Fiber Manufacturer and Transformation actor

I want:
An overview when I log into the platform to see all my materials including which materials have been viewed or where I have been contacted.

So that:
I can check and verify what materials have been uploaded and who is trying to get in contact with me.

Additional context information
As a manufacturer/ material supplier I want to see my material library to check materials that have been uploaded, edited e.g., history. Also, see appendix B of deliverable 3.1, ontological requirements.

Functional requirements:

- Easy navigation
- Dashboard overview with all my products and information I am sharing
- Function to add/edit product information e.g., a newly received certificate

2.3.4 TUS4: Access to trustful data

As a: Transformation actor

I want:
Access trustful data of the fibers and other materials I used in my transformation process (properties, origin of materials/fibers and the conditions in which they have been produced/ cultivated)

So that:
I can remove expired or old data.

Additional context information:
Textile product labels often (or even only) show the countries where the fibers are processed. However, my customers and the brands are requesting information on the recycled content, country of origin of the fibers and the conditions in which they were produced or grown (pesticide or not, good working conditions or not, etc.). Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Production conditions:
  - The Fairtrade Textile Standard
  - GOTS
  - C2C
- Fiber properties:
  - Product Type
  - Facility Name & Country
  - Material Name

- Lot No.
- Restricted Substances List (RSL) self-declaration
- REACH compliance
- RoHS compliance
- Hazardous (MSDS)
- Transaction certificate for recycled content (GRS, etc.)
- For Biomaterials:
  - LCA to confirm the mass balance)
  - ISCC certification
  - Carbon footprint (production scope)
  - Water/Energy Consumption* (see Higg Index)

2.3.5 TUS5: Generate material inventory

As a: Fiber supplier and Transformation actor

I want:
A platform that can generate material inventories (based on imported data from my ERP system or from digital document such as excel, json, etc.) and upload certificate.

So that:
I can facilitate my administrative work and decrease manual workload.

Additional context information:
Because it exists no standardized/automized Product Data exchange, I still have significant manual processes to do & poor data quality. Also, see appendix B of deliverable 3.1, ontological requirements.

Functional requirements:

- Auto-fillable fields based, e.g., on certificates that have been checked e.g. by machine readable pdfs or certificate numbers (e.g. GOTS number) OR imported data.
- Upload system

2.3.6 TUS6: Sustainability score

As a: Transformation actor

I want:
A visible and transparent score on my product sustainability/circularity performance

So that:
I can show my sustainability efforts.

Additional context information
I want to show my sustainability efforts to my customers so they can be rewarded. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Circularity score of the product based on a list of criteria (to be detailed in iteration 2) e.g.

- Non-virgin content (Recycled content and renewable content)
- Longevity
- Recyclability
- Biodegradability

2.3.7 TUS7: Circular materials catalogue

As a: Brand

I want:
To have access and explore freely a catalogue of available circular materials.
To improve the design phase of my products (eco-design).

So that:
I can improve the circularity of my products.

Additional context information
I am looking for more sustainable components than my current ones to create circular products: where and how can I find this information? Does it exist? Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Catalogue of sustainable/ circular Materials e.g., material library
- Materials record (sheet)
- Search engine by characteristic/ alternative to/name/
- Possibility to filter for materials e.g., by categories, composition, properties

Functional requirements:
- Search functionality
- Filter functionality

2.3.8 TUS8: Component data

As a: Brand

I want:
To have access to data on properties, assembly methods and composition of components

So that:
I can assure the quality and the sustainability of the material

Additional context information
To ensure the quality of final products and communicate objectively about them, I need information: how can I be sure that I have the right content of the materials used? Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Fiber properties (see list of data for fiber supplier)
- Assembly methods (e.g., gluing, stitching, etc.)
- Added substances or product in the composition
- Long-term access to the data of materials I bought

2.3.9 TUS9: Certificates

As a: Brand

I want:
Recognition of recycled material though certificates, labels, etc.

So that:
I can avoid greenwashing and avoid bad press and I can obtain trustworthy data.

Additional context information
To achieve my sustainability goals, I want to use recycled materials: how can I be sure I do it the right way? Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Mechanism to ensure trustworthiness of data e.g., by checking claims through certificates, certificate numbers

2.3.10 TUS10: Materials composition

As a: Brand

I want:
- To access data on manufacturing process on how fibers have been assembled AND/OR the quantity of resources used in the process.
- To create waste minimization strategies
- To find eco-friendly alternatives.

So that:
I can know the composition of the material I use to make my products.

Additional context information
For example, natural rubber used for shoe soles, and leather used in upper shoe materials are naturally occurring biodegradable biopolymers, However, to provide stability and good properties in service, these materials have been chemically modified to produce cross-linked stable structures. It's the same story for dyeing/printing and finishing treatment phases. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Quantity of resources used in a process.
- Nature and quantity of substance or material added to the fiber in the assembly process.
- (Semi-finished components) Materials properties (e.g., water repellent, fire resistance, washable, etc.)

2.3.11 TUS11: Authentication of data

As a: Brand

I want:
To access to secure and validated data (i.e., composition of material) through the platform.

So that:

I can trust and rely on it.

Additional context information
Can I trust the data listed on the platform? What mechanisms are in place to ensure the reliability and security of the data? Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Validated data.

Functional requirements:
- Authentication process of the accessed data

2.3.12 TUS12: Visibility

As a: Brand

I want:
Mechanisms boosting visibility of sustainability & circularity efforts.

So that:
I can improve/proof my communication on sustainability actions to avoid greenwashing.

Additional context information:
If I provide sustainable and circular products, I want to have a safe and trusted way of communicating this to my customers and stand out from greenwashing. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Objective(-able) arguments on product sustainability

Functional requirements:
- Dashboard to download a summary sheet of my product's sustainable properties.

2.3.13 TUS13: Product availability data

As a: Brand

I want:
Display my circular and sustainable products in the platform including all product details.

So that:
I can make products available and even cross-link to materials uploaded by manufacturers, fiber suppliers.

Additional context information
To be detailed in later versions of the deliverable. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Product data such as name, brand name, variation, prices, sizes, colors, material category, material type, reverse supply chain information

Functional requirements:

- Space to fill in all product related data including save button
- Image upload for the product
- Delete button if product is not available anymore

2.3.14 TUS14: Brand's take back schemes information

As a: Retailer

I want:
To access information on brands that offer product that can be remanufactured AND ways to sell them the products back.

So that:
They can remanufacture products or reuse parts.

Additional context information
I want to set up a “take back” program to be more involved in circularity at my level: which shoes can I take back and why? (In general, it makes more sense to reduce or even minimize waste than to develop extensive treatment schemes and techniques to ensure that waste poses no threat to the environment). Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Information on Brand’s potential take back scheme or programs

Functional requirements:

- Contact button

2.3.15 TUS15: Repair and reuse guidance

As a: Retailer

I want:
To access guidance on how to repair or reuse product.

So that:
I can reintroduce them on the market.

Additional context information
I want to reuse old shoes and sell them through second-hand markets. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Repair guide
- Reuse guide

2.3.16 TUS16: Sustainability product data

As a: Retailer

I want:
To access sustainable data on the product from the brands
So that:
I can support sustainable purchase.

Additional context information:
Sustainability aspect is increasingly becoming important for my customers. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- General product information
- Material composition (high level)
- Sustainability claims
- Information and guidance to correctly dispose of shoes

2.3.17 TUS17: Verified claims

As a: User

I want:
To access trustful and understandable data on circularity and sustainability aspects of the shoes

So that:
I can make informed choices and choose more sustainable and circular products.

Additional context information:
Sustainability criteria are important for choosing the shoes. But I have difficulty to get meaningful information and verified claims. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- General product information
- Material composition (high level)
- Sustainability claims
- Information and guidance to correctly dispose of shoes.

Functional requirements:
- Permanent link (QR code or others) between the physical product and the digital information

2.3.18 TUS18: Care guidance

As a: User

I want:
To access information on the appropriate treatment to my shoes (e.g., wash, care for)

So that:

I can maintain my shoes in good condition.

Additional context information:
I face the difficulty to know what care treatment to apply to my shoes. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Care guide information

2.3.19 TUS19: User guidance

As a: User

I want:
To access guidance on how to replace shoes elements (i.e., inner sole, outer sole, laces)

So that:
I can extend the life of my shoes.

Additional context information
I face the difficulty to know on how I can repair my shoes. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Repair guide
- List of critical spare parts which are expected to be repaired/replaced during the lifetime of the shoe

2.3.20 TUS20: Take-back data

As a: User

I want:
To access guidance on how to dispose my shoes after I don't want them anymore.

So that:
They can be properly valorized.

Additional context information:
To make sure the footwear product is just not thrown into the bin the user requires more information. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:
- Information on take-back channels if available and collection points

2.3.21 TUS21: Resale product information

As a: Collector and sorter

I want:
To access product information

So that:

I can make informed decisions about whether and how to resell a certain product.

Additional context information
Business model of sorters and collectors is mainly based on the resale potential of textile products. Therefore, I am looking to maximize the resale potential of used shoes. Also, see appendix B of deliverable 3.1, ontological requirements.

Data needs:

- Product information
- Product name,
- Brand name
- Description,
- Color,
- Size,
- Category of fiber (fabric, yarn, trim, etc.)
- Type of material (Specific type of a material depending on the chosen category of a fiber)
- Original price
- Time of market entry
- Resale demand

2.3.22 TUS22: Material inventory

As a: Collector and sorter

I want:

- To access to material inventory
- To build knowledge about mechanical and chemical recycling destinations

So that:
I can valorize it in the best way possible (best available technologies).

Additional context information:
Materials significantly influence, not only the life of the footwear but also the end-of-life treatment of the product. Approximately 40 different materials can be used in the manufacturing of a shoe.

Data needs:

- Valorization methods and actors
- Information on legal restrictions regarding resale, repair, sorting and recycling of already used footwear products.
- Material composition with data such as
- Product with name, type, category & country code (ISO country list)
- Brand name
- Variation with name, description (consumer facing description provided by brand), year of sale, price, images, color, size, country of origin.
- Material with name and composition, content, percentage, is recycled.
- Material component steps with step type (Origin of raw material e.g. Production, Spinning
- Tanning, Pre-Tanning, Dyeing, Finishing, Printing), country, color, category (trim, yarn, fabric, leather etc.) and country

2.3.23 TUS23: Disassembly

As a: Recycler

I want:
To access guidance on how to disassemble the components.
To access material inventory

So that:
I can valorize it in the best way possible (best available technologies).
I can cleanly separate the components and get high quality recycling materials.

Additional context information
Materials significantly influence, not only the life of the footwear but also the end-of-life treatment of the product. Approximately 40 different materials can be used in the manufacturing of a shoe.

Data needs:
- Disassembly methods and guidance
- Material properties- see properties for sorters

2.4 Generalization of user stories

The intention of the generalization is to look at the user-stories from all three use-cases with the intention of identifying commonalities. Based on the generalizations done in the first project iteration there are additional concepts that have been uncovered since the initial version of D2.1 in 2022.

2.4.1 Circular Value Network

Our starting point for this concept is an analysis of several terminologies, ontologies, and emerging standards, including the emerging standards in ISO 59004, the Circularity Thinking methodology, as well as a generalization over the project use cases and requirements in D6.1 and D2.1. The value network works according to a blueprint, which describes the planned setup, with needed roles possible to fill by certain actor types, types of circular strategies targeted (e.g. refurbishment of a product), and relations to typical value propositions and goals. See deliverable 3.1, ontological requirements for further detail.

2.4.2 Actor

For all the three use-cases actors that perform tasks in the user-stories have been identified. A circular value network is in essence composed of a set of actors filling certain roles in different phases of the network's flows. Hence, the actors are the ones that actually realise the value network, and perform the work to transform materials, components, and products in the various steps in the value network phases. There are several actors that are common for the three use cases:

- Supplier
- Recycler
- Sorter
- User
- Manufacturer

See deliverable 3.1, ontological requirements for further detail.

2.4.3 Product and part

The concept of a product exists in user stories from all the use-cases. However, characteristics attributed to a product differ depending on the user-story. See deliverable 3.1, ontological requirements for further detail.

2.4.4 Material

The concept of materials exists in user stories from all the use-cases. See deliverable 3.1, ontological requirements for further detail.

2.4.5 Location

Resources have a specific location at a certain point in time, but can also have a point of origin, and a trace of places where it has been. Similarly for actors, information etc. For certain use cases very specific kinds of location information may be needed, such as that something is located on the second floor of a building in a construction use case setting, or the exact coordinates of a crate of products for pick-up. While in other cases location information such as the country of origin of a certain product or material may suffice. Hence, we need both a generic notion of location, but also a "pluggable" structure where more specific models can be added for specific use cases. See deliverable 3.1, ontological requirements for further detail.

2.4.6 Process

Each circular value network realises one or more circular value flows, which can be seen as a process of transforming some resource, e.g. from materials, to components, into products, and then potentially back again. Such processes have different phases, e.g. the phase that takes something from materials to components, or the phase of deconstructing a product into its material composition, and each phase can further be subdivided into smaller steps (pieces of work), which can be performed by different actors. Each step may have inputs and outputs, both in terms of resources, but also work, energy, and information, for instance, and may result in some waste. Steps can be performed by actors, i.e. participants in the value network, with the right capabilities. See deliverable 3.1, ontological requirements for further detail.

2.4.7 Resource

Resources are at the core of the value network, since they are the things that are needed as input and output of each step. Most prominently the resources are the materials, components, and products that the network aims to manage circularly, but resources can also include the additional materials needed for processing, such as consumables or catalysts, the work and investments needed. See deliverable 3.1, ontological requirements for further detail.

3 Non-functional requirements

The following chapter outline non-functional requirements as derived from the project specification. Non-functional requirements are listed per sub-section to denote what part of the developed solutions they affect.

3.1 Interoperability

- Interoperability of data needs to be done using shared vocabularies and languages for knowledge representation.
- Vocabularies and languages for knowledge representation needs to adhere to the FAIR principles for scientific data.

3.2 Security

- It should not be possible to manipulate source data by an unauthorized actor.
- It should not be possible to manipulate data in transit by an unauthorized actor.
- The source code of the circularity platform can be uploaded to a publicly accessible online software repository (e.g., GitHub, Bitbucket), under an opensource license.

3.3 Privacy

- Storage and handling of data related to individuals and organizations need to adhere to the standards of the European General Data Protection Regulation (GDPR).
- Interoperable data needs to be managed in a privacy preserving manner.

3.4 Usability

- Clear guidance and instructions on how to use the solutions developed needs to be provided.
- Code should be clearly documented.

3.5 Scalability and performance

- All solutions developed needs to scale with performance given an increase of utilization.
- As a user that is using the solutions developed, they should not get the perception that the solutions have poor performance.

3.6 Availability

- Data needs to be recoverable from accidental and malicious deletion.
- Operations needs to be recoverable from disasters as well as malicious attacks.

4 Circularity requirements

The following chapter outlines circularity requirements that will be used to evaluate the methodology for systemic circular solutions developed within WP5. These circularity requirements will also indirectly be used by WP3 in deducing ontological requirements tied to circular value networks themselves.

The requirements development is based on the Circularity Design Framework conceptualized in D5.1, the state of knowledge review around resource-, energy-, information-, and value-flows in the context of value chain design. The Circularity Design Framework consists of three levels:

The conceptual levels of the Circularity Design Framework	Explanation of each level
Circular Metabolism Factor (First order principles)	Circular factors propose superordinate design considerations for the development of circular value networks.
Circular Enablers (Second order principles)	Circular enablers provide more specific requirements for the realisation of each factor.
Implementation actions (Third order principles)	Implementation actions deliver specific suggestions how an enabler can be implemented for material, energy, and value flows.

Table1: Overview of the Circularity Design Framework developed in D5.1

As the circular enablers provide more specific requirements for the realization of each factor, we are now defining these factors as circularity requirements within this deliverable. The circular metabolism factors are used to group the requirements due to their subordinate character.

In summary, we have outlined 13 circularity requirements. The implementation actions listed for each requirement will be used for the evaluation of the methods under development in WP5, however, they present a first draft and significant changes are expected regarding the implementation actions.

4.1 The capacity to understand the system and its relations.

For detailed explanations of each capacity group of circularity requirements, see chapter 3.3.1, design principles for circular metabolisms in the deliverable 5.1 (state of knowledge review).

4.1.1 CE1: The capacity to understand interrelations between processes and actors in the system.

Energy implementation actions:

- The ability to understand all parts of energy (i.e., exergy and anergy).

Value implementation actions:

- The ability to consider a diverse variety of value forms (incl. economic, environmental, and social)

4.1.2 CE2: The capacity to identify and consider all (relevant) system actors.

Material implementation actions:

- The ability to identify connections by analysing (large amounts of) supply chain data.

4.1.3 CE3: The capacity to consider processes throughout entire life cycle.

Material implementation actions:

- The ability to collect data along entire supply chain.
- The ability to observe and track materials (in real time) throughout all life cycle phases.

Energy implementation actions:

- The ability to collect and analyse large amount of data fast.
- The ability to visualise and simulate all processes.

4.1.4 CE4: The capacity to understand interrelations with other systems (at different levels).

Material implementation actions:

- The ability to identify connections by analysing (large amounts of) supply chain data.

Energy implementation actions:

- The ability to understand carbon intensity and sustainability of energy sources.
- The ability to visualise and simulate all processes.

4.2 The capacity to evaluate actions & processes.

For detailed explanations of each capacity group of circularity requirements, see chapter 3.3.1, design principles for circular metabolisms in the deliverable 5.1 (state of knowledge review).

4.2.1 CE5: The capacity to scope (new) combinations of processes.

Material implementation actions:

- The ability to analyse the feasibility of resource exchange.
- The ability to record material specifications and activities in central and standardised unit.
- The ability to understand the connection of the quality and quantity of flows.
- The ability to incorporate data from various sources.
- The ability to visually capture processes.

Energy implementation actions:

- The ability to trace materials back to their origin to evaluate energy consumption.
- The ability to identify energy requirements of rebound effects from material flows.
- The ability to consider alternatives for achieving efficiency.
- The ability to forecast energy demand and supply.

- The ability to assess technical feasibility.

Value implementation actions:

- The ability to evaluate the economic feasibility of material and energy strategies.
- The ability to account for social and environmental externalities.
- The ability to develop holistic value proposition.
- The ability to identify activities for value creation, capture, and delivery.
- The ability to develop core objectives.
- The ability to understand value created, value destroyed, value missed.

4.2.2 CE6: The capacity to understand system barriers and external factors.

Energy implementation actions:

- The ability to consider macro level energy infrastructure and legislature.

4.2.3 CE7: The capacity to understand the effect of (a set of) actions (on the system).

Material implementation actions:

- The ability to understand success factors of exchanges.
- The ability to measure and compare material flows.
- The ability to evaluate direct and indirect effects.

Energy implementation actions:

- The ability to evaluate energy consumption and carbon emissions.
- The ability to analyse large amount of data fast.
- The ability to manage the dynamic and complexity of energy data.
- The ability to measure rebound effects.
- The ability to establish (prompt) feedback structures.

Value implementation actions:

- The ability to measure economic, environmental and social value each.
- The ability to combine all dimensions of value for a comprehensive evaluation.
- The ability to assess value created, missed, destroyed.

4.3 The capacity to adapt.

For detailed explanations of each capacity group of circularity requirements, see chapter 3.3.1, design principles for circular metabolisms in the deliverable 5.1 (state of knowledge review).

4.3.1 CE8: The capacity to acquire and share (new) knowledge.

Material implementation actions:

- The ability to track actions and decisions made by system actors.

Energy implementation actions:

- The ability to collect data during all life cycle phases.
- The ability to incentivize the sharing of data.

4.3.2 CE9: The capacity to develop new configurations.

Material implementation actions:

- The ability to understand the qualities and characteristics of a material.

Energy implementation actions:

- The ability to collect and process dynamic and complex energy data quickly.
- The ability to simulate processes to identify efficiency potential.

Value implementation actions:

- The ability to define different types of value.
- The ability to understand underlying needs and wants.

4.4 The capacity of actors to collaborate.

For detailed explanations of each capacity group of circularity requirements, see chapter 3.3.1, design principles for circular metabolisms in the deliverable 5.1 (state of knowledge review).

4.4.1 CE10: The capacity to work together for a shared goal.

Material implementation actions:

- The ability to share infrastructure (Hardware and software).
- The ability to align processes.

Energy implementation actions:

- The ability to share infrastructure (Hardware and software).
- The ability to collaborate for energy recovery.
- The ability to bring together all energy sector stakeholders.
- The ability to share information on energy demand and surplus.

Value implementation actions:

- The ability to collaborate for value (co)creation, value transfer and value capture.

4.4.2 CE11: The capacity to integrate (relevant) actors throughout entire process.

Material implementation actions:

- The ability to incentivize cooperation.
- The ability to establish reciprocal information exchange.

Energy implementation actions:

- The ability to allow and encourage active engagement by users (i.e., prosumers).
- The ability to collect and provide consumption data during use phase.

Value implementation actions:

- The ability to include stakeholders during identification of value.
- The ability to integrate stakeholders in evaluation processes.

4.5 The capacity to manage the system.

For detailed explanations of each capacity group of circularity requirements, see chapter 3.3.1, design principles for circular metabolisms in the deliverable 5.1 (state of knowledge review).

4.5.1 CE12: The capacity to coordinate processes and actors for the benefit of the system.

Material implementation actions:

- The ability to manage risk in case of exchange failure.

Energy implementation actions:

- The ability to manage energy exchanges decentralised.
- The ability to make decisions automatically.

Value implementation actions:

- The ability to establish shared vision and align objectives.
- The ability to ensure that responsibilities and obligations are met.

4.5.2 CE13: The capacity to interact and share information with actors in an effective and trustful way.

Material implementation actions:

- The ability to share information transparently and traceably.
- The ability to standardise material information.

Energy implementation actions:

- The ability to share information transparently and traceably.

Value implementation actions:

- The ability to verify value creation.

5 Data catalog

This section outlines a list of basic data sources that was known and available to the development of the circularity platform at the time of completing the first version of this requirements specification, D2.1. This list will not be updated in this deliverable going forward, but instead, it is incorporated in the deliverable 7.5, Exploitation and Data Management Plan, and will be updated as part of that deliverable.

Data format	Accessible through	Interaction	Owner	Additional information
Excel	File	Manual	RS	List of materials and related service offerings
Json	API	Live	RS	Retrieving active service orders. Requires registration.
Excel	File	Manual	CON	Data on pricing for dismantling of materials, deconstructability of materials and possible pollutants in materials.

Table2: Initial data sources as identified in the first version of the deliverable.

6 Conclusion

This deliverable contains four main parts covering functional requirements, non-functional requirements, generalizations based on the three use cases and circularity requirements. As a legacy, it also contains an initial data catalogue listing the initial data sources identified as being available to the project at the creation of the first version of this deliverable. This list will not be updated in this deliverable going forward, but instead, it is incorporated in the deliverable 7.5, Exploitation and Data Management Plan, and will be updated as part of that deliverable.

Functional requirements are described as user stories whereas non-functional requirements are listed under separate headings as data requirements. The non-functional requirements will be further detailed in coming versions of this deliverable as work in WP3 and WP4 will provide better understanding related to scoping these requirements in a way that makes sense to how the platform will be operated.

In working with this deliverable, we have made use of the use-case descriptions produced in WP6 as input for defining more detailed requirements. Most time have been spent on working out actor's and the respective actions they take and describing this in text as user stories. The number of user

stories produced by each use case vary, as do the detail of those stories. In this second version of the deliverable, details have been added to requirements in all the use cases, additionally, we have also added a new chapter with circularity requirements.

Working through the first iteration of the project it became clear to us the circularity requirements where not visible enough. These requirements are implicit to the whole project as they are part of the underlying methodological framework used. Also, they are continuously worked on as part of WP5. Now the circularity requirements are visible and possible to reference in the other WP:s in the project.

Work done in between the two versions of this deliverable have added to the understanding of what is possible to generalize between the use cases, in this version we have made references to that work. Going forward, new generalizations that are made as the ontology and platform progresses will be included in this deliverable. As the first generalizations made in this document was done on the initial use case descriptions six months into the project, enriching them with what has been done in later phases of the project is needed to keep consistency in the requirements.

Working with the requirements as represented in this document have proven to be a good basis for further development. Later WP:s have been able to make use of these requirements and further detail and enrich them for their respective use. Furthermore, connecting back to these requirements in the validation don in WP6 is a good way to keep consistency and traceability in what is developed.