ONTO-DESIDE

DELIVERABLE

D5.2 Multi Flow Circular Value Network Design & Development Method

Deliverable number	D5.2
Deliverable name	Multi Flow Circular Value Network Design & Development Method
Work package	WP5
Lead partner	UHAM
Contributing partners	-
Deadline	2024-08-30
Dissemination level	Public
Date	2024-08-30

PROJECT INFORMATION

Project summary

Circular economy aims at reducing value loss and avoiding waste, by circulating materials, components 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, and a decentralized digital platform that enables collaboration in a secure and privacy-preserving manner.

The project addresses a number of 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, analyse and assess new circular value chain configurations opened up 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
12	Prague University of Economics and Business	VSE	Czech Republic

Document reference

Project acronym	Onto-DESIDE			
Programme	Horizon Europe			
Grant agreement number	101058682			
Project URL	https://ontodeside.eu/			
EU Project Officer	Giuseppina LAURITANO			
Project Coordinator	Name	Eva Blomqvist	Phone	+46 13 28 27 72
	E-mail	eva.blomqvist@liu.se	Phone	
Project Manager	Name	Svjetlana Stekovic	Phone	+46 13 28 69 55
	E-mail	svjetlana.stekovic@liu.se	Phone	+46 701 91 66 76
Deputy PC	Name	Olaf Hartig	Phone	+46 13 28 56 39
	E-mail	olaf.hartig@liu.se	Phone	
Deliverable name	Multi Flow Circular Value Network Design & Development Method			
Deliverable number	D5.2			
Deliverable version	Version 1			
Deliverable nature	Report			
Dissemination level	Public			
Due data	2024-08-31			
Delivery date	2024-08-30			
Keywords	Circular Economy; Circular Value Chain Design; Multi-Flow Method			

Document change log

Version	Date	Description	Authors	Checked by
0.1	2024-07-22	Initial outline	Charis Luedtke, based on discussions with Fenna Blomsma	
0.2	2024-08-20	First complete draft (excl. images & appendices)	Charis Luedtke & Fenna Blomsma	Mikael Lindecrantz
0.3	2024-08-28	Complete Draft	Charis Luedtke & Fenna Blomsma	Fenna Blomsma

Document approval

Version	Date	Name	Role in the project	Beneficiary
0.2	2024-08-23	Mikael Lindecrantz	Internal Reviwer	RS
1.0	2024-08-30	Fenna Blomsma	WP5 leader	UHAM
1.0	2024-08-30	Eva Blomqvist	PC	LIU

Table of Content

Abbreviations

CE	Circular Economy
WP	Work Package
UHAM	University of Hamburg
MFM	Multi-Flow-Metabolism
M	Month
T5	Task within work package 5 of Onto-DESIDE
D5	Deliverable within work package 5 of Onto-DESIDE
CDF	Circularity Design Framework
CMF	Circular Metabolism Factor
RC	Research Clarification
DS	Descriptive Study
PS	Prescriptive Study
DRM	Design Research Methodology
Bv1/2	Version Beta 1/2 (of the Multi-Flow Value Chain Method)

List of Figures

List of Tables

List of Appendices

Summary

This deliverable presents the advancement of the Multi Flow Metabolism framework into a method that supports the innovation of circular economy value chains. Presented here is the first iteration of the Multi-Flow Method: a method focusing on how best to bring a systemic perspective to understanding circular value chains and its constituting flows. The Multi-Flow method serves as a foundation for developing a robust and comprehensive approach to support ongoing innovations in the circular economy. The method was developed through a scientific foundation and process (based on Design Research Methodology), whilst working with real world applied cases (the use case of Onto-DESIDE). That is: a first version was created using insights from the use cases and tested with them. Learnings and insights from this process served to further advance the method.

The current version that is the outcome of the process described within this report consists of two parts: 1) the Flow Analysis, and 2) the Action Organisation. Part 1 includes six individual boards, called mapping tasks, for Resource flows, Value flows, Energy flows, Infrastructure and enabling assets, Information flows, data, memory & computation, and System environment. The purpose of these mapping tasks is to create a shared understanding of barriers and enablers for the respective flows and generating relevant actions to address shortcomings. Part 2 consists of four steps: Collect & Cluster, Refinement, Prioritisation, and Time Planning. The purpose of this subsequent step is to condense and organise the actions in a way that helps participants to take initiative and ownership, but also see where they can collaborate (e.g. have shared responsibilities and mutual interests). A first facilitation guide was developed along with the Multi-Flow Method to enable participants to use the method independently.

While it was possible to integrate some improvements opportunities identified throughout the development process already into the current version, other adjustments require further work, some of which will be taken up in the next iteration of this task. The next steps of WP5 thus include: a second phase of literature review, conduct further expert interviews, and the identification of an application case outside the project to test the method with participants who were not involved in the development process so far.

1   Introduction

Today society faces many severe environmental challenges, such as biodiversity loss, resource depletion and climate change. Many of these consequences can be traced back to the predominant linear economic system as the current 'take, make, use, dispose" paradigm has led to the consumption of resources beyond the regenerative capacity of our ecosystems[1,2]. It becomes apparent in society's excessive resource usage: at the moment, humanity uses the equivalent of 1.7 earths[3]. The number increases to 2.8 earths if everybody would live like an average EU resident. A radical shift in current production and consumption patterns and the organisation thereof is required[4]. Circular Economy (CE) is regarded as a promising alternative approach which simultaneously respects planetary boundaries and ensures economic and societal well-being[5,6]. However, despite its potential, the implementation of a CE is still at a nascent stage.

Amongst other barriers, the 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 attempting to create new circular value networks. The use of different terminologies and the absence of consistent definitions makes it difficult to create new ecosystems of actors in Europe today. Onto-DESIDE will address these challenges by leveraging 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 seeks to make decentralized data and information understandable and usable for humans as well as machines and will develop a data sharing platform for the digitalised CE. That said, the research required to bring Onto-DESIDE to a successful conclusion in the future is twofold. On the one hand, the transdisciplinary project requires research in the field of ontology modelling and for the development of an ontology-based data sharing platform. This work is conducted by work package (WP) 3 and 4 in close collaboration with WP2. On the other hand, given that Onto-DESIDE aims to contribute to the transformation of the European industry into a CE, further research, and knowledge creation regarding the design of circular value networks is required. Within Onto-DESIDE, these efforts are led by the team of the University of Hamburg (UHAM) and are concentrated in WP5. The report at hand is the second deliverable by WP5 and constitutes the first iteration of a tool and method to identify value chain improvement opportunities – and the process that was followed to create it.

This introductory chapter continues with a short overview of the concept of CE and briefly presents the preceding research that builds the foundation for the work in Onto-DESIDE, namely the Multi-Flow-Metabolism (MFM) developed by Blomsma and colleagues[7]. This is followed by an overview of the tasks of WP5 before the objectives of this deliverable are described. Section 1 concludes with an outline of the remainder of the report.

1.1   Introduction to Circular Economy

In essence, Circular Economy is an umbrella concept that groups a wide variety of strategies, all for the purpose of value retention, reduction of value loss or alternative ways of value creation[1,7,8]. In its early stages, CE focused on waste and resource management strategies that aimed at extending product and material life through strategies such as recycling and remanufacturing[8]. While such circular strategies are, amongst others, still an integral part of the implementation of a CE, the understanding of a circular economy nowadays is more holistic, and challenges established assumptions. That is, CE encompasses a wide range of strategies that promote product, component and material conservation, efficiency, and productivity, e.g., recycling, reuse, maintenance, and manufacturing. Moreover, CE also involves strategies that look more directly at how value can be created or value loss reduced from a system point-of-view, e.g., for all stakeholders[7]. The concept of CE thus requires a rethinking of not only how resources flow through systems, but also who benefits and in what way, in order to realise the urgently required shift from the current linear

economic model to a circular economic system[4,9]. This implies that more holistic and collaborative approaches are required[4,9].

As an alternative economic model which can support sustainable development efforts, CE has received attention from scholars, businesses, and policy makers[1,2,10]. This, for example, is reflected in the European Union's "Circular Economy Action Plan" (CEPA). As an important part of the European Green Deal, the CEPA "paves the way for a cleaner and more competitive Europe"[11] and thus aims to directly influence business and the way it operates. Onto-DESIDE contributes to the realisation of this action plan as the developed solutions will allow for the automation of planning, management, and execution of circular value networks, at a European scale, and beyond. However, despite the recognition of the potential of a (European) circular economy, the implementation of holistic circular value networks is still in its infancy, partly due to a lack of understanding of the complex system that circular networks represent and the ongoing interactions.

Previous research has shown that multiple flows play an integral part for a robust circular metabolism. That is: the industrial metabolism - the 'flows' that make up the lifeblood of systems such as economies - can be seen as consisting of resource- (e.g. physical), energy-, information- and value-flows[12–15]. It is when these flows are aligned and work collaboratively that metabolisms function harmoniously and within planetary boundaries. This occurs when value is provided to all relevant stakeholders by means of physical flows that respect the carrying capacity of the planet and which are facilitated by sustainable energy flows and supported by relevant information when needed. When large-scale metabolism changes happen such as when systems grow or advance to a new system state, these 4 flows - together with the accompanying infrastructure and technology - change in an integral manner to allow for new flow patterns to emerge[13–16].

Within CE the relevance of these flows is also acknowledged: see, for value flows, for example, work by Bocken et al.[17] or Pieroni et al.[18]; for information flows see the work by Kristoffersen and colleagues[19]; and see for energy flows the work by Cullen[20], Allwood and colleagues[21], or Bakker and colleagues[22]. So far, in CE, these 4 flows are studied with either an exclusive focus on one flow, or as a set of two, usually in relation to resources. However, Blomsma and colleagues[7] have recently shown that considerations regarding these 4 flows feature prominently and - crucially - *together* in circular oriented innovation. They are considered in relation to each other and designed together. For this reason, the Multi-Flow Metabolism (MFM) model was proposed to bring together these 4 flows (see Figure 1) and to emphasise their co-dependence in creating a sustainable circular metabolism.

Multi-Flow Metabolism

Value flows
+ infrastructure

Information flows
+ infrastructure

Energy flows
+ infrastructure

Material flows
+ infrastructure

The 'layers' of the industrial system: each layer depicts a key 'flow' incl. its infrastructure and technology that are vital to transitioning from one metabolism state (linear) to a second (circular) one.
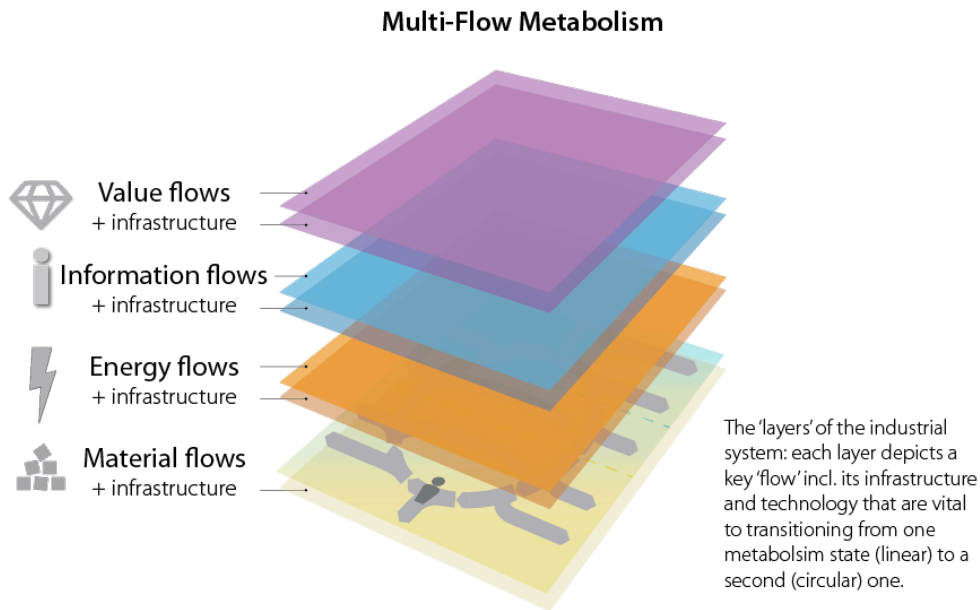
Figure 1 The Multi-Flow Metabolism by Blomsma et al. (2022)

However, at present, no comprehensive or authoritative guidance exists as to what a robust circular metabolism looks like – and how these 4 flows can be made into a coherent whole that operates within planetary boundaries. Previous efforts to provide such guidance primarily take the form of circular design frameworks that propose a variety of design principles[2]. Examples of such frameworks are: Material Efficiency, which focuses primarily on the relationship between the production and circulation of materials and energy[21,23]; Cradle-to-Cradle which highlights three main principles: waste equals food, current solar income should be used, and diversity should be celebrated and diversity should be celebrated[24,25]; and the Blue Economy which proposes a list of 20+ such principles, including cascading through multiple kingdoms, replacing something with nothing, and generating multiple benefits[26]. These frameworks have several shortcomings. They a) do not systematically cover all fours flows, b) have limited scientific underpinning, and/ or they can c) vary wildly in the number and type of principles they propose, resulting in little trust in them. This means that there is a gap as to what guidance to adhere to when designing robust, sustainable, and circular metabolisms.

For change agents within business and other organisations this hinders the design and implementation of circular value chains, as it means that tools and methods to scan for and identify improvement opportunities that consider these 4 flows holistically are lacking. Considering both the pressing need to transition to more sustainable and circular industrial systems[27,28], as well as the current willingness and momentum to act[11,29]; this gap needs addressing urgently. Therefore, as part of the WP5 work within Onto-DESIDE, the MFM will be further developed into a method and tool that addresses this gap.

1.2   Tasks and Deliverables of Work Package 5

WP5, titled "Multi flow circular value network design & development method", is led by UHAM. WP5 will (further) conceptualise, develop, validate, and implement tools and approaches that transform the MFM model into a method for the accelerated development of systemic circular solutions. The goal of this WP is to close the gap between idea and action for a CE and to turn the MFM into a strategic tool for use within Onto-DESIDE and also beyond.

WP5 consists of three tasks (T5):

- T5.1: Review state of knowledge (M1-18) – lead: UHAM
- T5.2: Operationalisation & maturing (M10-30) - lead: UHAM, participants: CON, POS, CIRC, FAS, RS
- T5.3: Consolidation of method (M25-36) - lead: UHAM

and three deliverables:

- D5.1: State of knowledge review – report (amended to M11 with approval of EU project manager)
- D5.2 Multi flow circular value network design & development method Version 1 – report (amended to M27 with approval of EU project manager)
- D5.3 Multi flow circular value network design & development method Version 2 – report (M36).

The three tasks build on each other, yet they are also interrelated and overlap in time. The first task lays the foundation for the work within WP5, through an assessment of the current state of knowledge and practice around resource- (e.g. physical), energy-, information- and value-flows in the context of value chain design. A structured review draws from and consolidates knowledge and guidance for the design of these four flows from across different fields such as systems and complexity science, as well as the circular economy and supply chain fields. D5.1 summarises the findings of the initial state of knowledge review. This task, however, continues until month (M) 18. In combination with the second task that is the topic of this report, T5.2, the outcomes of D5.1 will be further developed and operationalised by turning them into a first version of guiding tools and methods. The developed methods, covered in the report at hand, will then be tested with the help of the industry partners and adjusted in an iterative approach. A description of these methods are summarised here as are the steps that were taken to get there. D5.2 also has a project milestone associated with it, i.e., Milestone 10: "First version of MFM methods", which subsequently culminates in delivering T5.3: consolidation of methods (M36) and D5.3. The work done in T5.2 and T5.3 serve as the foundation for the development of part of the training materials within WP7. The corresponding task in WP7 is also led by UHAM. The final report, D5.3 describes the finalised methods and tools, including a 'how-to' guide or manual aimed at a business audience.

In summary, WP5 develops a method and tool for the design and development of circular value networks with the end goal to produce a tool that supports the use-cases within Onto-DESIDE (WP6), but that can also serve a wide variety of other circular value chain efforts beyond the project. WP5 has a reciprocal relationship with the other WPs in that it also provides the frameworks and methods to study circular value networks within Onto-DESIDE. In turn, the methods brought forward in WP5 will be based on a sound theoretical foundation and the requirements of the industry cases (WP6), scoped by WP2. Where possible, WP5 outcomes will also be translated into ontological and further technical requirements for the construction of the Open Circularity platform by WP3 and WP4.

1.3   Preceding Deliverable: State of Knowledge Review and Remaining Gaps

The preceding "State of Knowledge Review" report – D5.1 - reviews and synthesises the (then) current state of knowledge on resource- (e.g., physical), energy-, information- and value-flows in the context of value chain design. The objective of this report was to summarise existing research on design guidelines for a robust circular metabolism and to lay the theoretical groundwork for the tools and methods to be developed within WP5. This resulting five categories of Metabolism Factors and related second and third order principles are used as input for the development of a first version of tools and methods in this current work.

This current work addresses several gaps. First, as little comprehensive guidance currently exists on how to design and develop circular value chains, it focuses on designing and (further) developing circular value chain configurations: e.g. according to what principles circular value chains should work and how the resource- (e.g. physical), energy-, information- and value-flows thus should 'flow'. The assumption is that some idea, concept or current configuration of a value chain exists, but that this first and the subsequent versions of the tool and method support creating robust and well-functioning value chains – since they need to function as a whole: one of the defining differences compared to linear value chains, where little feedback exists. In this way, the method and tool will support continued and strategic development of circular value chains – allowing them to grow and outcompete linear ones.

1.4   Deliverable Objectives

This iteration of the method and tool focuses on how best to bring a systemic perspective to understanding circular value chains and its constituting flows. That is: to understand the practitioner/ business perspective on how to design and develop circular value chains. Specifically:

- o   How do they view systemic barriers & enablers and their agency to address them;
- o   What themes or topics are important for them – in past and future developments;
- o   How does this relate to the different relevant flows, as well as to infrastructure and information flows (MFM).

The goal is to operationalise the Metabolism factors for use in a business context and understand where and how to connect or integrate this with the practitioner perspective. As such, the objective is to both define and further develop the process or steps to take for designing and developing circular value chains – the method, as well as the supporting visual aids and templates – the tools. Combined, we refer to this output as the *Multi-Flow Method*. Through this way of working – having a scientific foundation and process, whilst working with real world applied cases – the result is expected to be a robust and comprehensive method and tool, that can be used fruitfully to support ongoing change efforts. That is: WP5 is developing process support aimed at enabling innovation capacity for a circular economy – and this report narrates the first iteration.

1.5   Input from other WPs

This task is executed in synergy with WP6 and the deliverable D6.3 titled "Use Case Needs Analysis and Circular Value Flow Mapping" (Version 3) – that provides an overview of the industrial needs of the three use cases as analysed by the use cases through the use of the frameworks and methods provided by WP5. As such, we can draw on the insights from the 3 project use cases – textiles, electronics and construction. This, in turn, feeds into WP2 and the deliverable D2.3 titled "Project requirements specification and research methodology" (Version 3) which defines requirements for the development of the Open Circularity prototype (to be developed in WP4). In this capacity WP5 supports the progression towards the project goals.

This way of collaborating was already established and followed in previous iterations of the project. One of the outputs of this – the use case mappings of the respective resource- (e.g. physical), energy-, information- and value-flows – which are described in more detail in D6.2, we use as a starting point for this current effort. We will refer to these as the *pre-mappings* to distinguish them from the current *mappings*.

The remainder of this report is structured in the following way. Section 2 explains the research approach used for the development of the Multi-Flow Method and gives an overview to Design Research Methodology (DRM). Section 3 presents the results of each DRM phase and introduced the first version of the method. Section 4 continues with the further development of the Multi-Flow Method before Section 5 then concludes with the implications for the subsequent work of WP5 and other WPs where applicable.

2   Research Approach

In this section we describe the process that was followed to arrive at the Multi-Flow Method Bv1.0 (tested with the use cases) and the improvements that were derived from this for Bv2.1, as well as the further work identified for subsequent versions. As per the project proposal, we follow the Design Research Methodology (DRM) process, which fits within the domain of design research, and is particularly suitable for developing boundary objects alongside the steps for their application.

2.1   Design Research Methodology

According to Blessing and Chakrabarti (2009)[30], design research aims to achieve two main goals:

- "the formulation and validation of models and theories about the phenomenon of design (…)" (p.5), and
- "the development and validation of support founded on these models and theories (…)" (p.5).

These objectives highlight design research as an appropriate approach to achieve the aims of WP5. That is: the goal of WP5 is to create innovation capacity to support the development of robust circular value chains. It is therefore the goal to understand and develop principles of value network dynamics and robust circular value chains, with a focus on resource- (e.g. physical), energy-, information- and value-flows. In order to close the gap between idea and action of circular value chains, appropriate methods and tools need to be designed to support the accelerated development of systemic circular solutions. As circular value chains are only an emergent phenomenon - they exist, but are not yet dominant in our economies - it is necessary to learn both from the guidance that is available from system and complexity science (which has studied a wide variety of aspects of systems), as well as from early examples from practice. As such, different streams of knowledge need to come together in a format that can be used with and, preferably, by practitioners.

Therefore, WP5 uses Design Research Methodology (DRM) by Blessing and Chakrabarti[30]. DRM consists of an iterative process, where, after an initial research clarification, descriptive and prescriptive phases follow each other until an approach is sufficiently mature. Here, the descriptive phases are aimed at understanding (aspects of) the tool or application process, where the prescriptive phases codify these learnings and insights into (visual) aids or templates that can be used as boundary objects during the process, as well as the steps and guidance that is needed to derive meaningful insights from them. Figure 2 illustrates the generic process of DRM on the left (ibid.), and how it is applied within WP5 on the right. Each DRM process stage is further explained in the following subchapters, including how the process is applied for the current deliverable.
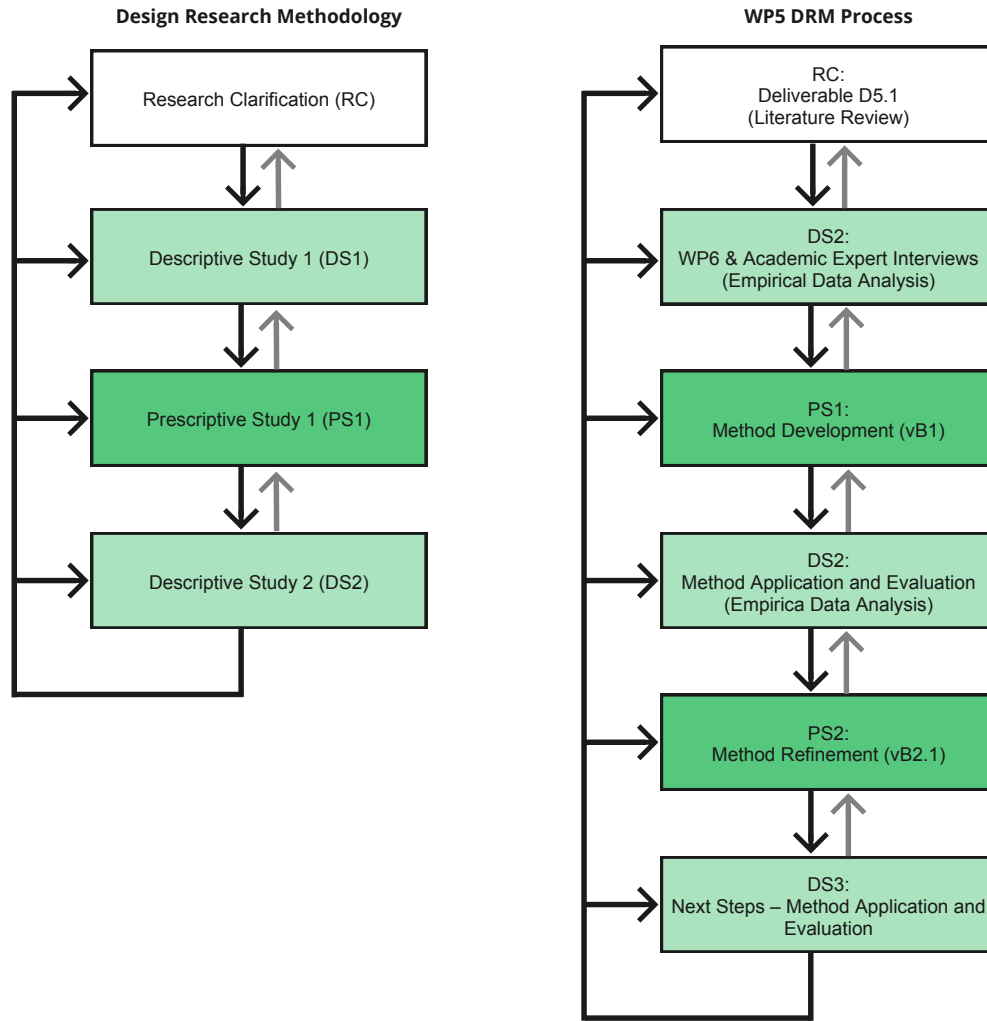
Figure 2 Design Research Methodology Process of WP5

2.2   Research Clarification

The primary objective of the Research Clarification (RC) phase is to establish the research goals, specifying what the research is expected to achieve and verifying the existence of knowledge and/or practice gaps. This phase involves identifying the main research problem(s) and developing an understanding of the current situation concerning the phenomenon of interest, primarily through reviewing the current state-of-the-art. This is often accomplished through a literature review. The objectives of the RC phase thus include:

- Setting clear goals for the research project
- Establishing an initial reference model.

Within the context of WP5, the literature review part of Deliverable D5.1 on the current state of knowledge on resource- (e.g., physical), energy-, information- and value-flows in the context of value chain design provides this. Table 1 presents the key findings and results of D5.1.

Table 1 Overview of D5.1 Key Findings and Results

Key findings of the literature review
• A gap with regards to holistic design of relevant flows exists. • The concept of value currently lacks a clear definition in the context of circular value chains. • Infrastructure (as an enabler of circular value chains) is only scarcely covered in the literature.
Main results of D5.1
• The MFM was restructured based on the finding that information flows should not be regarded separately from material, energy, and value flows, but rather be included for each of the remaining flows individually. It now consists of material-, energy- and value flows each with respective information flows and enabling infrastructure. • The Circularity Design Framework (CDF) was developed as an extension of the MFM framework. The framework consists of three levels of principles: the circular metabolism factors (1st level), the circular enablers (2nd level), and the implementation actions for material-, energy-, and value-flows (3rd level). The CDF will be used to transfer the underlying processes of a circular metabolism into design guidelines to be used within Onto-DESIDE and beyond. The CDF can be viewed in Appendix 2.

Building on the overall objectives of WP5 within Onto-DESIDE and considering the work completed within WP5 during the first half of the project, the goals for this design research project are now defined as follows:

- Mindset – To foster a systemic perspective on circular value chains that encourages those involved in circular innovation to consider the behaviour and functioning of the entire value chain, recognising how interactions among different parts over time can lead to new behaviours and outcomes, while also rethinking not only how resources flow through systems, but also who benefits and in what way.
- Knowledge (theory) – To gain a deeper understanding of the dynamics and interconnections among resource, energy, and value flows, along with their respective information flows, infrastructure, and enabling assets, to facilitate the development of robust circular value chains.
- Knowledge (practice) – To translate the insights gained on these four flows into (design) principles of circular value chains that are meaningful and actionable in interrogating circular value chain designs.
- Usability – To transform the MFM into a strategic tool for practitioners in a business environment to scan for and identify improvement opportunities that consider the 4 flows, for use within Onto-DESIDE and also beyond.

The restructured MFM and the Circularity Design Framework, both results of D5.1 (see Appendix 1 and Appendix 2), will serve as the initial reference models for this design research project. The MFM illustrates the inclusion of the multiple flows and their interconnectedness, serving as the conceptual starting point for the method and tool development. The Circularity Design Framework provides an initial structure for organising principles of circular metabolisms, including all four flows. Together, these two components serve as foundational reference models for both 1) method and tool development and 2) structuring the principles of circular metabolisms.

2.3   DS1 – Descriptive Study 1

The objective of the DS1 stage is to gain a clearer understanding of the existing situation. It is further the goal of DS1 to identify potential key factors pertaining to the current situation. That is: where the RC verified and clarified the knowledge gap ("yes, there is a problem: here is the outline of it"), the first DS is targeted at understanding the different dimensions or elements of a problem ("these dimensions play a key role: this is the shape of it"). Defining these is an important step towards for the first prescriptive study, as grasping the key influences that shape the present situation allows for

designing ways to address it ("here is how we propose to go about improving it"). The primary means for DS1 is the collection and analysis of empirical data.

Specifically, within WP5, the goal of DS1 was to better understand how systemic barriers and enablers of circular value chains are perceived by value chain actors – and how this relates to the CDF. That is: what barriers and enablers are seen as key for the functioning of the value chain as whole – and what language is used to described them? Therefore, WP5 hosted interview sessions with each use case. Table 2 provides an overview all sessions conducted during the Spring of 2024.

Table 2 DS1: Overview of Use Case Interviews (04 - 05/2024)

Use Case	Session length and participants

Construction use case	• (1) April 2024
	   o 60 minutes
	   o 1 RS; 1 CON; 1 LIND
	• (2) May 2024
	   o 90 minutes
	   o 1 RS; 1 CON; 1 LIND

Electronics use case	• (1) April 2024
	   o 60 minutes
	   o 1 CIRC; 1 REIA
	• (2) May 2024
	   o 60 minutes
	   o 2 CIRC
	• (3) May 2024
	   o 60 minutes
	   o 1 CIRC; 1 REIA

Textile use case	• (1) April 2024
	   o 60 minutes
	   o 2 POS; 1 FAS; 1 TEX
	• (2) April 2024
	   o 60 minutes
	   o 1 POS; 2 TEX

All sessions were conducted online, facilitated using slides and an online collaborative whiteboard (Miro). All sessions were recorded and transcribed.

The sessions were designed to explore and identify systemic barriers and enablers. That is: to discover barriers and enablers that impact the functioning of the entire value chain – as opposed to merely applying locally to a single actor (e.g. their specific business model, value proposition or technical problem – since other tools are already available for these things). The discussions aimed to understand how value chain actors conceptualise and perceive the overall functioning and shortcomings of their value chains as a whole. Conversations included concrete case examples (products discussed within the use cases) and the circular strategies in focus, but further included the sector as a whole, as well as the broader system environment. To analyse the collected data, all interview transcripts were coded to identify common themes related to the existing barriers and enablers faced by these actors, as well as solutions that have been successfully implemented in the past to achieve their current configurations. Themes were, where possible, assigned to the different flows. This approach allowed for identifying topic clusters highlighting key factors of circular value chains (presented in 3.1). The use case sessions also helped to gain an understanding of how to bridge the academic and business language when it comes to what works well and what does not in value chains.

2.4 PS1 – Prescriptive Study 1

During the first prescriptive study (PS1) phase, researchers utilise their improved understanding of the problem situation to begin the systematic development of a support tool for the defined research problem. Drawing on the insights gathered in DS1 regarding the key factors of the research problem, multiple variations of potential support solutions are developed to create a first version.

In the context of WP5, the PS1 took place in May and June 2024, overlapping partly with the DS1 phase. The goal was to develop a first version of the Multi-Flow Method, thereby turning the MFM into a tool for the improvement of circular value chains. The development process of the first version of the value chain method and tools, referred to as Version Beta 1 (vB1), included exploring different possible approaches of what the method flow and the steps could look like and what output would be generated. For that, different existing approaches and canvases were explored as inspiration, for example: from business and organisational science, e.g., the business model canvas by Osterwalder & Pigneur (2010)[31] and variations of it, and from the systems thinking community, e.g., the systems design canvases for complex systems by Jones & Van Ael (2022)[32]. Among the different variations developed, the three most notable were the following approaches:

- A processual approach, i.e., the methodology evolving around *how to start, how to operate*, and *how to develop* – split up for the different flows;
- A topic centred approach, i.e., constructing the four flows as layers and using topics across all four flows;
- A flow centred approach, i.e., dividing the methodology by the flows and developing topic specific for each flow.

The development and evaluation process of the different approaches was done through critical reflections by the WP5 researchers and the engagement in role play activities to understand what a support tool would need to assist value chain practitioners in identifying improvement opportunities. The method variations were assessed based on their strengths and weaknesses of the different processes and on their coverage of the different topic clusters identified in DS1 and the findings of the RC stage. In addition to the WP5 internal development sessions, three feedback and demonstration sessions were hosted with a member of the Construction and the Electronics use case, respectively and a member of the advisory board. In these sessions, the partners and advisory board member were presented with a run through of the method under development and asked for their critical feedback. Their feedback was then used for the finalisation of the first Beta version of the methodology.

The core outcome of the PS1 stage is the vB1 method whose goal it is to examine how the circular value chain can function better as a whole and to identify improvement opportunities for circular economic value chains (see Figure 3 below). The method consists of two parts; the first being on the left side of Figure 3 and the second part being on the right.
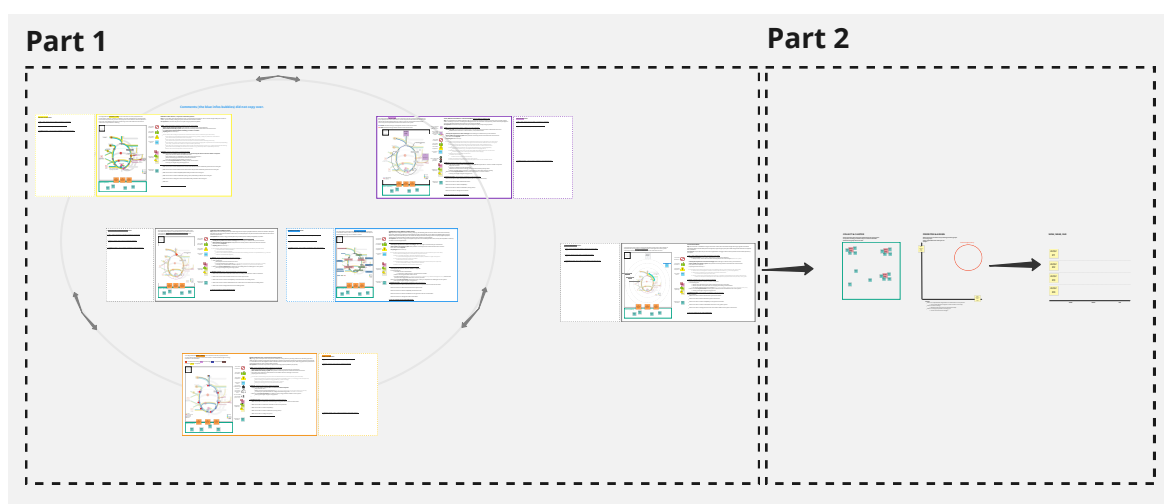

Figure 3 Overview of Method Version Beta 1

The first part includes a workspace for the analysis of barriers and enablers, and the identification of actions for each flow individually – each workspace being called a *mapping task.* The first part of the method includes six different mapping tasks:

1. Resource flows
2. Value flows
3. Energy flows
4. Infrastructure and enabling assets
5. Information flows, data, memory & computation
6. System environment.

All six mapping tasks share the same general structure, yet they include topic specific prompts. The second part concerns the planning and organisation of the actions developed within the first part of the method, allowing participants to transition from analysis to the generation of actionable steps. The full Bv1 method is explained in detail in 3.2.

2.5   DS2 – Descriptive Study 2

The objective of the second descriptive stage (DS2) is to evaluate the support developed in the previous prescriptive phase ("what, of our prosed solution, works well and what doesn't?"). The evaluation focuses on two key aspects: the *application* and the *success* (or effectiveness) of the support. Specifically, it must determine whether 1) the designed support is functional for its users and whether it is applicable to fulfil intended purpose (application evaluation), and 2) whether the support is useful in achieving the purpose (success evaluation). In the context of the method and tools under development in WP5, this means evaluating whether 1) the method facilitates the identification of improvement opportunities for circular value chains, and 2) whether the results generated by the method lead to actual improvements in circular value chains. The evaluation assesses whether the method is sufficiently complete, effective, efficient, easy to use and operational. Empirical data is collected to conduct the evaluation through testing the method.

For the evaluation and assessment of the first version of the method during testing, evaluation criteria were developed. The evaluation criteria were developed based on the steps and considerations proposed by Sonnenberg and vom Brocke (2012)[33] as well as Tuunanen et al. (2024)[34] and adapted to fit the evaluation of the Multi-Flow Method. Table 3 presents the evaluation criteria used for the *application evaluation.*

The *application* criteria will be used as the primary evaluation criteria for Prescriptive Study 2 (PS2) and are applied to the general observations and the formal feedback in Chapter 3.3. A longer period is necessary to judge whether the Multi-Flow Method is *successful* in improving circular value chains, i.e., if the actions identified within the method support practitioners to achieve actual value chain improvements.

Table 3 Multi-Flow Method Evaluation Criteria

Criteria used for the *Application* evaluation
Completeness: This criterion examines whether the Multi-Flow Method covers all necessary aspects and elements necessary for circular value chain development and tthat no critical factors are overlooked.
Level of detail: This criterion checks whether the Multi-Flow Method provides sufficient granularity in its analysis. It assesses if the method offers detailed enough insights to allow practitioners to understand specific areas for improvement (and to take action).
Understandability: Understandability focuses on how easily the method can be comprehended by practitioners. It assesses whether the language, concepts, and steps involved in the Multi-Flow Method are clear and understandable, allowing users to effectively apply the method without confusion.
Ease of Use: This looks at how user-friendly the Multi-Flow Method is for practitioners. It evaluates whether the method is straightforward to apply, does not require extensive training or expertise, and can be easily integrated into existing workflows by circular value chain practitioners.
Efficiency: This criterion assesses how quickly and resource-effectively the Multi-Flow Method can identify improvement opportunities. It measures whether the method allows practitioners to achieve their objectives in a timely manner.
Effectiveness: Effectiveness evaluates the ability of the Multi-Flow Method to successfully facilitate the identification of valuable improvement opportunities. It considers whether the method reliably produces actionable insights.
Operationality: This looks at how practical and applicable the Multi-Flow Method is in real-world scenarios. It examines whether the method can be easily implemented in different types of circular value chains and various operational contexts without significant modifications.

To test the method Bv1, WP5 organised use case specific workshops with WP6, which were held in June, July, and August 2024. As such, these tests were applications – not mere demonstrations. Following a kick off session, each use case received a minimum of three facilitated sessions with WP5. Table 4 provides an overview of all sessions (excluding the kick off session) conducted between WP5 and WP6, including session durations, participating partners for each use case, and which components of the method were covered. Since Bv1 consists of six mapping tasks (part 1), along with action planning and organisation (part 2), it was expected that completing the entire methodology for each use case could be overly time-consuming. Consequently, the mapping tasks were distributed among the use cases. This distribution was designed to ensure that 1) each mapping task was addressed at least twice to provide sufficient empirical data for evaluation within WP5, and 2) all use cases could perform a meaningful analysis of their respective value chains. While this deliverable report contains all insights and results related to the method's development, insights specific to each use case's value chain are detailed in deliverable D6.3, submitted by WP6 concurrently with this report in August 2024.

Table 4 Overview of all Workshop Sessions Between WP5 and WP6

Use Case	Session Number	Duration	Participants	Topics covered
Construction	1	90 min	1 CON; 1 LIND; 1 RS	Resource flows; Value flows
	2	90 min	1 CON; 1 LIND	Resource flows; Value flows
	3	120 min	1 CON; 1 LIND	Energy flows; Infrastructure
	4	90 min	1 CON; 1 LIND	Action Clustering; Prioritise & Assign; Time planning
Electronics	1	120 min	1 CIRC; 1 REIA	Resource flows; Value flows
	2	120 min	1 CIRC; 1 REIA	Infrastructure; Information flows; System Environment
	3	120 min	1 CIRC; 1 REIA	Action Clustering; Prioritise & Assign; Time planning
Textile	1	90 min	1 POS; 1 FAS; 2 TEX	Resource flows
	2	90 min	1 POS; 3 TEX	Resource flows; Value flows; Infrastructure
	3	120 min	1 POS; 3 TEX	Information flows; System environment
	4	60 min	2 POS	Action Clustering; Prioritise & Assign
	5	60 min	1 POS; 1 FAS; 1 TEX	Action Clustering; Prioritise & Assign

The primary objective of the evaluation was to identify what is effective, what requires improvement, and what additional elements should be incorporated into the method and tools. Two types of feedback were gathered: the observations made by the researchers (3.3.1.) and formal feedback (3.3.2).

The researchers' observations are derived from notes taken during each facilitated session, as well as reflections noted afterward. Observations relate to whether the overall objective of bringing a systems perspective to the cases and whether the participants responded to the methods, tools and facilitation in the manner expected. That is: where the participants able to contribute with their insights to generate the insights and actions needed for the further development of the value chain.

All sessions were recorded. The content of the observations made by researchers can be divided into three categories. First, there are general observations regarding 1) the method and its facilitation process, 2) the action planning process, and 3) the fit of the Circularity Design Framework (developed in D5.1) and the outcomes of the method development. Second, the researchers noted use case specific observations. Third, the reflections encompass the informal feedback gathered during the sessions. This informal feedback, originating from participants' observations and statements, is classified within the researchers' observations since it was recorded in the notes taken by the researchers, distinguishing it from the formal feedback collected.

The formal feedback was collected through a feedback survey sent out to all participants. The feedback survey was developed around the components and criteria identified in PS1 (2.4). The survey included a combination of multiple-choice questions and open-ended questions, along with a dedicated open feedback section to allow participants to share any additional thoughts. The structure of the survey was as follows:

- Section 1: Purpose of the Methodology
- Section 2: Methodology Design
- Section 3: Methodology Content
- Section 4: Methodology Facilitation
- Section 5: Participant Information.

Participant information was gathered at the end of the survey to help contextualise the feedback, however, only the use case affiliation was asked to allow participants to remain anonymous. The questions of the feedback survey can be seen in Appendix 5. The survey was designed to take approximately 20 - 25 minutes. Out of ten workshop participants, five filled out the feedback survey in time for the deliverable. The formal feedback was then summarised, and key learnings derived (see Table 8 in 3.3.2). All combined learnings from the researchers' observations and the formal feedback are then concluded and evaluations made on the application and the success of method vB1, resulting in a list of improvement opportunities.

Finally, considering the goals identified in the RC stage – specifically, to gain a deeper understanding of the principles of circular value chains – a first draft of insights on circular value chain development is developed.

2.6   PS2 – Prescriptive Study 2

Similar to the first prescriptive study, the objective of the second prescriptive study is to build upon the enhanced understanding acquired during the preceding descriptive phase and to develop the next iteration of the support tool ("how can we make it (even) better?").

For WP5, this means integrating the improvement opportunities identified in DS2 into the second Beta version of the method. However, while some improvement opportunities can be executed within

a shorter development timeline, others necessitate further research and must thus be completed over a longer period. Consequently, the improvement opportunities detailed in subchapter 3.3.3 are categorised according to their implementation timeline. Improvements included in the current deliverable were classified as pertaining to method Beta Version 2.1 (vB2.1) and were implemented in August 2024, while those requiring additional effort are classified under method version Beta 2.2 (Bv2.2.). The ongoing method development of the method involved reflections and assessments by the WP5 researchers, along with additional internal role play activities. The outcome, namely method Bv2.1, is discussed in Section 4. The corresponding first tool guide for the method is available in Appendix 7.

The evaluation criteria established during PS1 remain unchanged for the second version of the method, allowing for the assessment of progress against these criteria.

2.7   DS3 – Next Steps

The next step following the development of the vB2.1 method is the third descriptive study (DS3). This DS3 stage lies outside the scope of the current deliverable and represents the initial stage in the process of developing the follow-up version of the current deliverable – D5.3 Multi flow circular value network design & development method version 2, which is due month 36 and will serve as the final deliverable of WP5.

To prepare for the next deliverable, the subsequent actions to be taken within DS3 are outlined at the end of Section 3. This subchapter describes how to collect additional empirical data necessary for the advancement of the method.

3   Multi-Flow Method explained

In this section, we present the results of the different phases of the DRM research approach. We start by presented the results of the first descriptive phase, the spring sessions, before presenting the Multi-Flow Method Bv1 in Chapter 3.2. The third chapter presents the evaluation results from DS2 and concludes with a list of improvement opportunities for the method development.

3.1   DS1 – Spring Sessions

In the first descriptive phase, multiple interviews were conducted with each use case to identify what barriers and enablers are seen as key for the functioning of the value chain as whole – and what language is used to described them. The insights gained through the discussions on barriers and enablers were reformulated as questions – specifically questions that provide essential information for the development of circular value chains. The questions were organised according to the following categories: *how to start* the implementation of a circular value network (or more circular economic practices), *how to operate it* and *how to make the next step*. A separate category was created for *trends and developments.* Based on the categorisation and the questions, key themes were developed that reflect how the use cases collectively view circular value chains from a systemic perspective. Since the formulated questions developed in the first step inform the key topics, the categorisation and questions are not discussed separately in this chapter. Instead, Table 5 presents the developed key themes along with example questions for each. The themes are listed in no particular order. The complete overview of the categorisation that led to the development of these key themes can be found in Appendix 3.

The key themes build the foundation for the development the Multi-Flow Method. The key themes identified are:

- Benefits (incentives and risks)
- Resource Management
- Information Management
- System Environment
- Resilience and Adaptability
- Collaboration
- Infrastructure.

The emergence of benefits, resources, information, and infrastructure as key themes indicates that the MFM, as a conceptualisation of circular value chains, addresses the issues that practitioners face when working to enhance the circularity of value chains. Discussions regarding the system environment also highlight the significance of considering the embeddedness and interconnectedness of a particular value chain within larger super- and sub-systems. The themes of resilience and adaptability, as well as collaboration, can be seen as cross-cutting concepts that relate to the other themes.

These themes form the foundation for developing the Multi-Flow Method. The themes of benefits, resources, information, infrastructure, and system environment serve as individual building blocks in Part 1 of the method. The remaining two themes—resilience and adaptability, and collaboration—are incorporated into these blocks throughout the method. The theme of collaboration is also addressed in Part 2 of the method, as organising the actions necessitates consideration of collaborative efforts. The questions listed in Table 5 below inspired the creation of the guiding questions and prompts for the method.

Table 5 Key themes and exemplary questions (DS1)

Key themes	Example questions for the according theme

Benefits (incentives and risks)	Value/Benefits
	● What are the benefits that the implementation of the proposed solution brings? (e.g., meeting legislation, securing more funds,..)
	  ○ What are risks of implementing the solution? What are risks of not implementing the solution? (e.g., not meeting legislation)
	● What are the driving forces and motivations that influence the implementation of the proposed solution?
	
	Incentive Alignment
	● How do the existing incentives within the system align with and support larger-scale (macro) system goals and objectives/incentives?
	  ○ What changes might be necessary to ensure alignment and effectiveness?
	
	Different forms of value
	● What (different forms of) value can be generated within the system?
	  ○ Where in the system are these forms of value generated?
	  ○ Is new value created?
	  ○ How can (the different forms of) value be captured? (What infrastructure is necessary to capture this value?)
	  ○ Where in the system is value lost? (How could that be prevented?)
	● Where do trade-offs exist?
	
	Power distribution
	● How is power distributed and exercised among various actors within the supply chain system?

Resource Management	Resource Function and Quality
	● What function/purpose does the resource need to fulfil?
	  ○ What resources could be used for that purpose?
	  ○ Can an alternative resource be used?
	  ○ How can the resource's fit-for-purpose be checked?
	● How can resource quality be verified? [When is quality sufficient? Does flexibility regarding quality exist?]
	
	Supply/Demand
	● How is the supply for required resources? [high/low]
	● How is the demand for the required resources?
	  ○ What could impact these supply/demand ratios?
	  ○ What could be alternative/additional supplies? (secondary resources, cross sectoral collaboration)
	Readiness
	● Is the proposed solution already technically realisable?
	  ○ If yes - what is delaying the start?
	  ○ If not, what are the specific barriers? Do alternatives to the primary solution exist?
	
	Added requirements
	● If the proposed solution gets implemented: what other processes/resources will be required for the implementation?
	
	Scalability
	● What are enablers to scale technical feasible solutions?
	● Is sufficient capacity available to scale the solution?
	
	Technical aspects
	● Are enough resources available to scale the solution?
	
	Responsibility (Ownership)
	● Where in the system does responsibility for the resources / the product / the solution shift?
	  ○ Does this bring problems / opportunities? Which are these?
	● Are more/less responsibility transfers necessary?

Information Management	Knowledge (for implementation)
	● Does sufficient knowledge exist to facilitate the proposed solution?
	● Where is speciality knowledge/particular knowledge required? Is external knowledge required? Are external (experts) available to support the system?
	
	Information availability
	● What are the essential information requirements to initiate/to start (the implementation) of the proposed solution/within the system?
	● Is the necessary information readily accessible and accessible within the system?
	   ○ If the information is available, is it being effectively shared with relevant actors (who require it)? If not, what are the obstacles to sharing, and who is inhibiting the exchange?
	   ○ In the absence of available information, what alternative approaches could be employed to commence the process within the system?
	
	Knowledge/information transfer
	● What knowledge/information needs to be passed on to other system actors (to keep the system running)? (e.g., to customers or EOL actors)
	   ○ How can this knowledge be passed on? How can others be made aware of the knowledge/information availability?

System Environment	Interventions
	● What external interventions to the system exist? (e.g., legislation)
	   ○ What interventions can be expected?
	● What is necessary to follow current regulation? What does its enforcement entail? What are possible consequences?
	   ○ Is it possible to test the solution in a protected space? Or try it as a smaller scaled version?
	
	Alignment (with macro goals)
	● How does the proposed solution align with broader goals (higher system level goals)?
	● Does it contribute to macro goals/developments?
	
	Conditions of super systems
	● How do current macro developments and trends (e.g., legislative, market) influence the system environment?
	● What are anticipated developments that could impact the proposed solution and (societal) macro goals?
	● What (systemic) constraints exist and how do they shape the system environment (its dynamics and evolution)?
	
	(Inter)Connectivity to other systems
	● Where do connections to other systems exist? What are these?
	● What are the requirements to connect to other systems? What steps are necessary to connect it effectively with other circular systems to create a seamless integration?
	
	Conformance
	● Which system rules or standards are in place that necessitate adherence or conformance?
	● How does this impact the small scale system? (change)
	● What are possible consequences for not complying?
	● What additional rules/standards are foreseeable? How would they impact the system?
	
	Competition
	● Are all system actors subject to the same conditions?
	● If no - what consequences could this have?

Resilience and Adaptability	**Buffers**
	● Do buffers exist in the system?
	    ○ What types of buffers are these?
	    ○ How do they work?
	● Are more / less buffers needed?
	    ○ What effect will this have?
	
	Timing
	● When/Where does timing play a critical role?
	    ○ How does the timing influence the system?
	● Where can timing be leverage to create systems benefits? (e.g., through delays, through feedback processes)
	    ○ Where can timing become a bottleneck?
	
	Self-Reliance
	● In what ways can the system be adapted or diversified to proactively mitigate future challenges?
	● What strategies and mechanisms are in place to enhance the system's flexibility and responsiveness to evolving needs?
	
	System Characteristics
	● How does the (geographic/length) scope affect the system?
	● What creates robustness? What creates resilience?
	● What is the structural complexity of the system? (supply chain diversity and supply chain length)
	
	Alternative solutions
	● Were alternative solutions considered?

Collaboration	● Where within the system is collaboration considered essential? ● Which processes require coordinated efforts and organization? ● Do other entities within the system encounter similar challenges, and would collaboration be beneficial in resolving them? ● How could inter- and intra-system collaboration contribute to positive outcomes? ● What key actors need to be included or integrated for the comprehensive implementation of potential solutions within various points of the system? ● What additional requirements emerge as a result of integrating these key actors for the holistic implementation of solutions?
Infrastructure	**Infrastructure type and purpose** ● What types of infrastructure are required to operate the system? ● What purpose does the infrastructure serve? ○ Could alternative (infrastructure) solutions be used? (e.g., temporary solutions) **Infrastructure capacity and organisation** ● Is the required capacity available? ● How is the infrastructure organised? ● Could infrastructure be shared?

3.2 PS1 – Method Beta Version 1

As the Multi-Flow Method is under development, here we present the version that was used for the value chain interrogation with the use cases (Version Beta 1 - Bv1) - including how it was facilitated. The chapter starts with a method introduction (3.2.1) which includes the purpose of the method and relevant prior work. While this has been discussed in previous chapters of this report in greater detail, the two topics are nevertheless included here to showcase how the method is presented to participants. The chapter continues with an overview to the method and the general instructions (3.2.2). The individual steps and instructions for Part 1 and Part 2 of the method are then introduced separately, in 3.2.3 and 3.2.4, respectively. Images of the method are included in this chapter where appropriate, yet a full version of all method steps can be seen in Appendix 4.

3.2.1 Bv1 – Method Introduction

Method Purpose

Circular value systems differ from linear systems in that all components must work together for the system to function effectively and remain robust. After all, circular value chains are unique in the sense that feedback loops exist: their output is also their input. It is because of this that weak links within the system pose a threat to the entire circular system and each actor involved in creating and capturing circular value. Despite this, systemic thinking and analysis has been minimally applied in

the circular business realm. It is this gap, that the method aims to address: to strengthen the innovation capacity for circular value chains. The goal of the method is to support value chain actors in developing – including both design and improvement opportunities - circular economic value chains by applying a systems perspective and understanding how the circular value chain can function better as a whole. That is: instead of focusing on a small set of local phenomena, the method helps to examine the relationships between different points of interaction and how the sum of this creates the behaviour of the value chain. The Multi-Flow Method guides practitioners in their exploration of: What works well and what problems have been already solved? What does not function well and where do problems remain? What should the value chain look like and function instead – and what actions can be taken to get there?

Prior work
Within the processes of D6.1 and D6.2, the use cases generated mappings for each of the four flows – material, energy, value and information – within their circular value network. These mappings offer a visual representation of how the flows flow within their value network, providing a descriptive overview. The work completed in D6.1 and D6.2 lays the groundwork for each use case. The analytical approach of the Multi-Flow Method now enables partners to shift from a descriptive overview to a more detailed comprehension of their circular value chain and its relationships, aimed at uncovering shortcomings that prevent the value chain for further developing and scaling – and the value chain participants to create and capture circular value.

3.2.2   Bv1 – Method Overview and General Instructions

The method is facilitated on an online collaboration white board (Miro). Figure 4 offers an overview of the method and shows how the online white board for each use case looks. This subchapter gives an overview of Part 1 and 2. Detailed instructions will be provided in the subsequent chapters.
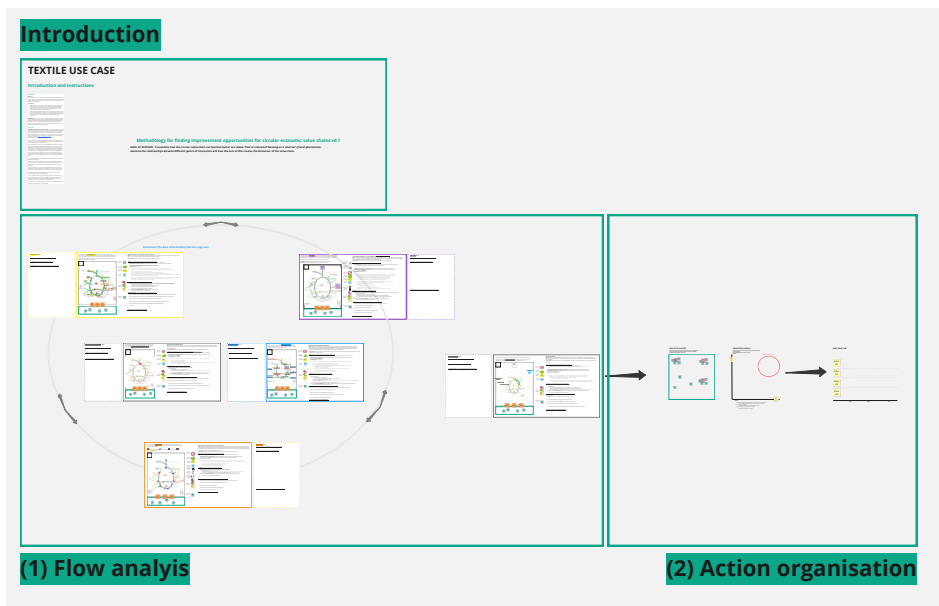
Figure 4 Overview of Online Collaboration White Board used for Facilitation

Overview
When participants first access the online whiteboard, they are automatically directed to the "Introduction" section. This section includes 1) an introduction to the method, covering relevant prior work, the background of its development, and the purpose of the methodology; and 2) offers a set of instructions for each mapping task. As an initial step, participants are encouraged to familiarise themselves with the workspace, i.e., to zoom in and out on the board to locate all elements within the workspace and take a first look at the method to understand its contents.

The process of the Multi-Flow Method consists of two parts: 1) the flow analysis and 2) the action organisation. Part 1) includes six individual boards, called *mapping tasks*, for:

- Resource flows
- Value flows
- Energy flows
- Infrastructure and enabling assets
- Information flows, data, memory & computation
- System environment.

The purpose of these mapping tasks is to create a shared understanding of barriers and enablers for the respective flows and generating relevant actions to address shortcomings. Whilst a barrier or enabler may feature in multiple mapping tasks, these different tasks serve to highlight different dimensions or aspects of it – and thus to gain a deeper insight into the respective topic.

The result of each mapping task is the identification of actionable items that are then used in the second part of the method, the action organisation. The purpose of this subsequent step is to condense and organise the actions in a way that helps participants to take initiative and ownership, but also see where they can collaborate (e.g. have shared responsibilities and mutual interests). The following is written from the perspective of self-facilitated sessions, because this will be the format of the training guides (WP7) - even though for this phase of the method development it was still facilitated by WP5).

The general steps for the Multi-Flow Method are the following (Table 6):

Table 6 Multi-Flow Method - Process Steps for participants

1) Choosing the first mapping task
As a group, choose one mapping task to start with. Even though it is not required to start with the resource flow mapping task, it can be helpful to start with of this mapping task. While all mapping tasks follow the same general structure (1. Map, 2. Analyse, 3. Generate actions), each task also includes prompts and questions specific to the task. Use these prompts to conduct the analysis. Then, copy all generated actions to the action repository.   *Additional information:*   • All mapping tasks include a mapping area (i.e., the image of the pre-mapping from D6.1 and D6.2) and an adjacent space for notetaking. You are free to take notes either on the pre-mapping (in form of the post its and icons) or in the designated text section. Either way, please make sure that you have a system that helps you understand which answers / notes belong to which part of the mapping. For example, you could number a part on the mapping according to the order of which you have taken the notes.
2) Continuing the mapping tasks
After completing the first task, choose another mapping task, follow the mapping task instructions and use the respective prompts.   *Additional information:*   • While you may approach the completion of the mapping tasks in order, it is likely that the mapping tasks will be an iterative process. That is: you will most likely switch back and forth at times between the mapping tasks as a conversation during one mapping task may trigger a thought for another one.
3) Completing sufficient number of mapping tasks
Even though all flows as well as the system environment and infrastructure tasks are considered to be important for gaining a detailed understanding of the circular value network as a whole, the completion of four mapping tasks may already be considered sufficient to fulfil the requirements of the first part of the method. Select the tasks that are most relevant to the value chain.   *Additional information:*   • (For D6.3 and D5.2 specifically) During the introductory session, each use case agreed on a specific set of mapping tasks to prioritise and which tasks to neglect in case of time shortage.

---

4) Copying *all* actions to Part 2

After you have finalised the mapping tasks, copy over *all* actions from the respective action repositories to the *collect and cluster* task. This starts the second part of the Multi-Flow Method. Please follow the instructions given in each step of Part 2, i.e., the *collect and cluster* step, the *prioritise and assign* step, and the allocation to the *now, near, and far* future to complete Part 2.

3.2.3   Bv1 – Part 1: Flow Analysis

Each mapping tasks consist of three parts: 1) a short introduction/overview of what the mapping tasks pertains to, 2) the instructions and guiding questions 3) a mapping area (and respective notetaking space). Figure 5 shows the value flow mapping task and serves as an example of all mapping tasks.
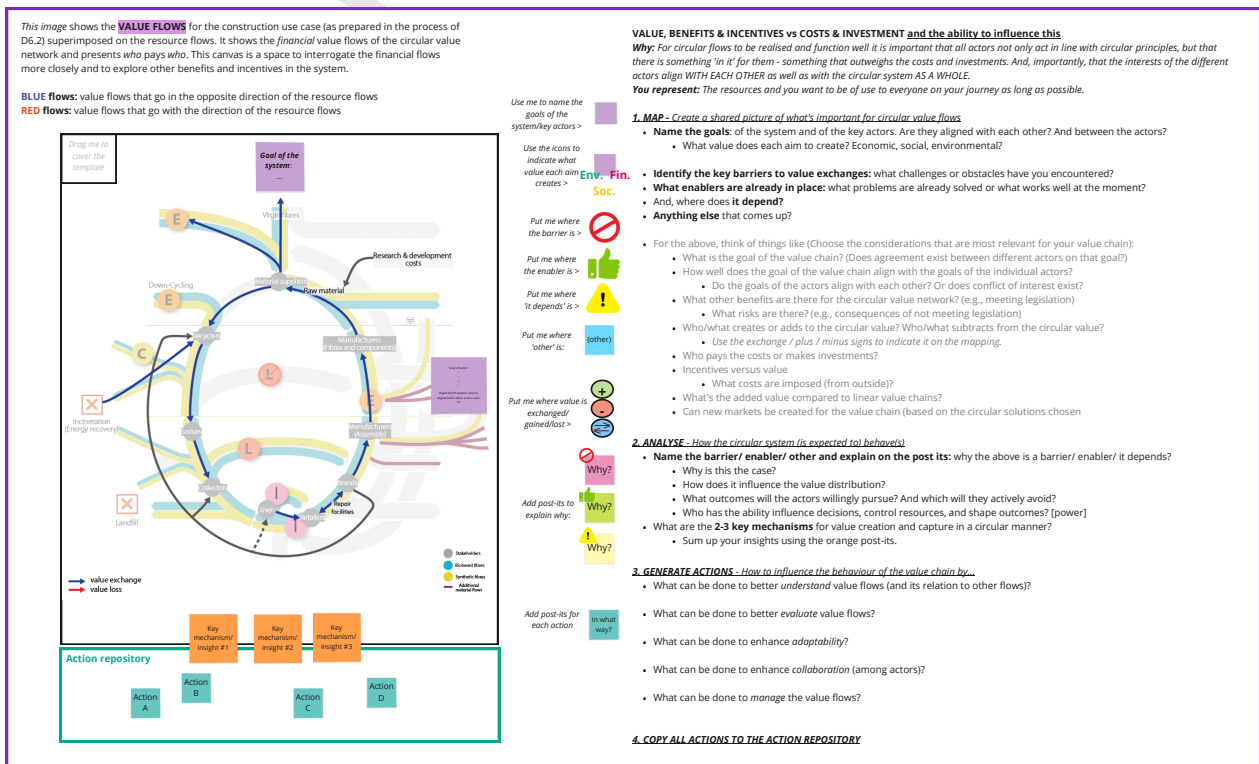

Figure 5 Mapping Task Example (Bv1.0) (notetaking space not pictured here to increase the readability of the image)

The mapping tasks start with a short description of what is included in the respective task and why it is important for circular value chains. For example, while the task is generally called *value flow* mapping task, it is meant to facilitate discussion around "value, benefits & incentives versus costs & investment and the ability to influence this". The description continues with the reasons for why these topics are important for the development of circular value chains. To support participants in shifting their perspective from the usual actor-centric perspective to a systems approach, a prompt is included to make participants aware of the perspective they should take, e.g., for value flows, one should think about barriers, enablers and actions from the perspective of the resources (i.e., the prompt: "you represent the resources and you want to be of use to everyone on your journey as long as possible"). This shall emphasise that the focus is not on how the value chain can work for the individual actor but rather how the flow of the flows can be enabled.

The first step is the *mapping* – "to create a shared picture of what's important for circular value flows". Within this step, participants are asked to identify key barriers for the respective flow (i.e., what obstacles they have encountered) and what enablers are already in place (i.e., what problems are

already solved or what works well at the moment). To guide the conversation, guiding questions are provided. Examples for value flows include:

- What is the goal of the value chain?
  - Does agreement exist between different actors on that goal?
- How well does the goal of the value chain align with the goals of the individual actors?
  - Do the goals of the actors align with each other? Or does conflict of interest exist?
- What other benefits are there for the circular value network? (e.g., meeting legislation)
  - What risks are there? (e.g., consequences of not meeting legislation)
- Who/what creates or adds to the circular value? Who/what subtracts from the circular value?
  - Who pays the costs or makes investments?
- What costs are imposed (from outside)?
- What's the added value compared to linear value chains?

Different coloured post its and different icons are provided to facilitate the transfer of discussions onto the mapping space so that discussions can be document, and a shared picture and understanding emerges. For example, green post its and a green thumb for enablers, or red post its together with a red crossed out circle for barriers The mapping tasks may also include additional icons specific for its topic. For example, the value mapping task also includes icons to indicate whether environmental, social, or financial value is discussed, and icons to show where value is gained or lost.

The second step is the analysis of "how the circular system (is expected to) behave(s)". This step is based on the findings from the previous mapping step – and is in reality often combined with step 1. Participants are asked to name the barriers or enablers and explain on the post its why it is a barrier, an enabler or why it depends. Example questions from the value flows include:

- How does it influence the value distribution?
- What outcomes will the actors willingly pursue? And which will they actively avoid?
- Who has the ability influence decisions, control resources, and shape outcomes?

To summarise the discussion and enable a focused conversation moving forward, participants will then summarise their insights into the key mechanisms (or root causes) of the flow. For value, the question to be answered is: What are the 2 – 3 key mechanisms for value creation and capture in a circular manner? The key mechanisms are recorded on the orange post its.

The third step is *generating actions* and understating "how to influence the behaviour of the value chain". To guide the conversation about action development, five guiding questions are proposed. The guiding questions are based on the Circular Metabolism Factors developed by WP5 in D5.1. The five factors (i.e., the capability to understand the system and its relations, to evaluate actions and processes, to adapt, to collaborate and to manage the system) reflect critical aspects of designing circular value chains. Therefore, they were chosen to guide the conversation on creating actions. All five *generate actions* questions remain the same for all mapping tasks, yet topic specific examples were provided within each mapping task. These examples were integrated in the method in the form of comments on the online white board and are not visible in Figure 5. Examples of the guiding questions for value include:

- What can be done to better *understand* value flows (and its relation to other flows)?
  - Examples for value flows – You may think of: if the creation of other types of value be of interest (e.g., easier (dis)assembly, health for workers or users (non-toxicity), simplified logistics, local employment, etc.)

- What can be done to better *evaluate* value flows?
  - o Examples for value flows – You may think of: understanding value created, destroyed, value missed; measuring financial, environmental & social value each; combining all value forms for one comprehensive evaluation; identifying activities for value creation, capture and delivery

The actions are noted on teal post its and placed with the respective barrier. After the completion of the action development, all post its are copied and placed in the action repository of each mapping tasks, the fourth and final step of the mapping tasks. This way, both a record exists of which barrier it pertains to as well as where in the system, and the actions are collected for ease of aggregation in Part 2 of the method.

3.2.4   Bv1 – Part 2: Action Planning Process

The second part of the method, the action planning process, begins by copying all actions from all action repositories and placing them below the *Collect and Cluster* step.

Collect and Cluster (Bv1)
The goal of this step is to condense the created actions and define key actions. Given the iterative process and the interconnectedness of the different mapping tasks, some actions may occur in multiple action repositories. The first step is thus to remove any duplicates. But also: to further specify and develop actions that are not yet distinct or clear enough. The second step is to group the actions according to whether they are related to each other. Then, to rename the action group with a new title that captures the commonality of the topic (Figure 6).
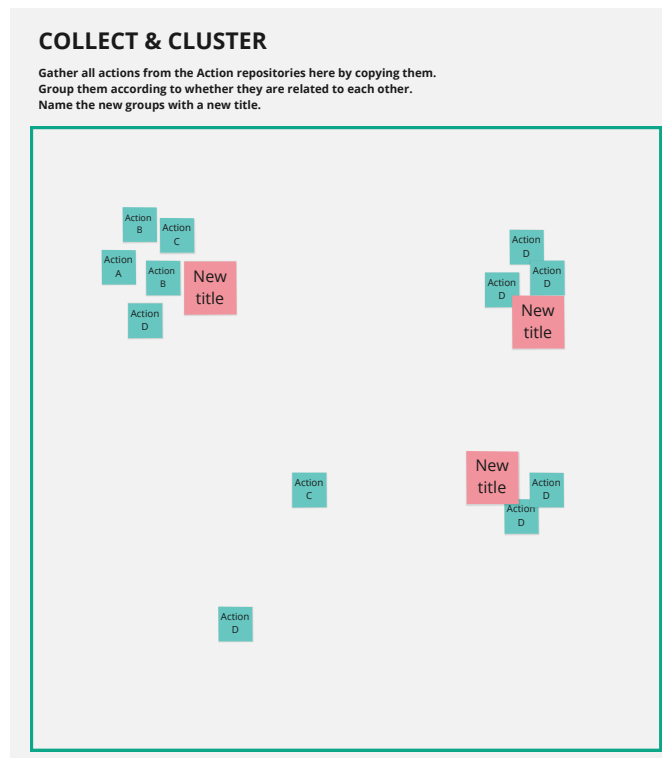

Figure 6 Method Part 2: Collect & Cluster (Bv1.0)

Prioritise and Assign (Bv1)

The second step of Part 2 is the prioritisation of the actions (Figure 7). First, participants must identify two criteria according to which they will prioritise the action groups. The action groups from the previous step are then copied over to the prioritisation workspace and placed on the graph according to their categorisation based on the criteria. This step may also help participants identify actions of highest priority. Where possible, responsible actors should be assigned to the action clusters.
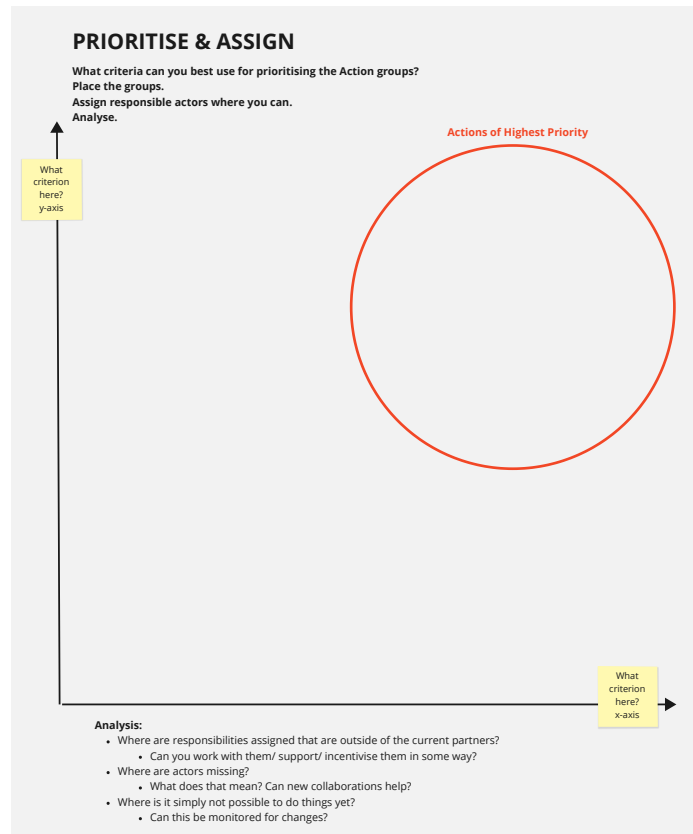
Figure 7 Method Part 2: Prioritise and Assign (Bv1.0)

Allocation to *now, near and far* future (Bv1)

The final step of the action organisation process is the allocation of the actions according to timing and actors (Figure 8). Relevant actors are listed on the yellow post its. The action groups are copied over from the previous steps to this workspace and then allocated 1) to the according actor, and 2) according to when this action shall be addressed. These two steps are done with the help of the insights from the prioritisation and actor assignment done in the previous step. For example, the prioritisation, and the identification of the actions of highest priority, may influence the timing considerations, i.e., whether an action shall be addressed, now, near or far. This step concludes the Multi-Flow Method and results in an overview of actions to be taken for each actor, as well as an indication of their common interests and shared responsibilities.

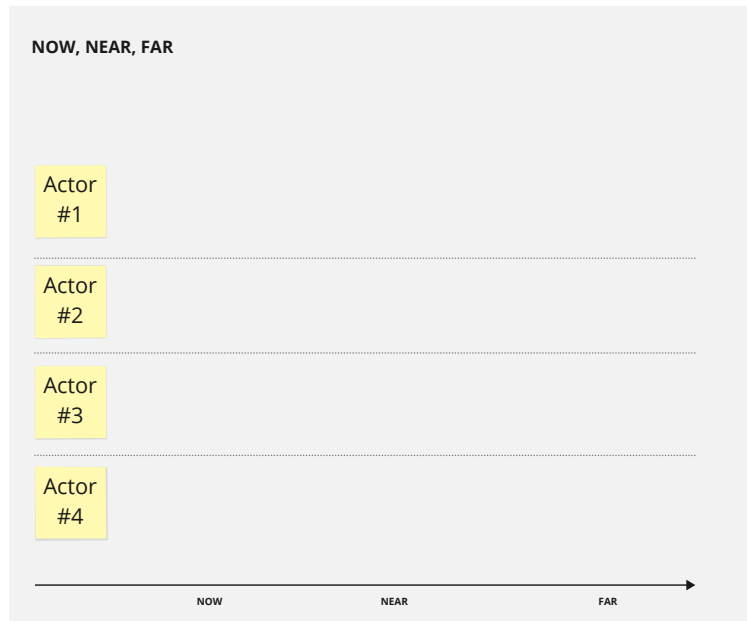Figure 8 Method Part 2: Allocation to Now, Near and Far Future (Bv1.0)

3.3 DS2 – Method Development

The following chapter reflects the learnings made throughout method development process, i.e., by hosting the methodology workshops with the use cases. The chapter presents the reflections made by the researchers throughout the process, informal feedback offered by participants and the results from the formal feedback gathered. The learnings are then summarised, and conclusions draws on the application evaluation and the success evaluation, resulting in a list of improvement opportunities. The chapter concludes with new insights learnt regarding the design of circular value chains.

3.3.1 Observations by Researchers

This subchapter presents the observations made by the researchers throughout the facilitated sessions with the use cases, consisting of three parts:

> 1. General observations
>   1.1. about the method and its facilitation process,
>   1.2. on the action planning process,
>   1.3. about the circular metabolism factors (identified in D5.1),
> 2. Use case specific observations, and
> 3. Informal feedback collected during the facilitated sessions.

1 General observations
The observations made about the methodology and its facilitation are classified into four categories: Methodology design, methodology process, methodology content (including the mappings tasks and the action planning process), and the facilitation. Table 7 offers the observations made by the researchers, their respective categorisation, and which evaluation criteria (as defined in 2.5) the observation relates to. The categorisation is not mutually exclusive, i.e., an observation may be assigned multiple categories. The same feedback categorisation are used for the presentation of the formal feedback (3.3.2) to ensure consistency and better clarity of the feedback collected. The table is followed by observations on the action planning process, and on the circular metabolism factors. The subchapter is concluded by a short summary of the observations.

Table 7 General Observations Made by the Researchers

#	Observation	Feedback Category	Evaluation Criteria established in DS2 (2.5)
#1	**Time Investment vs. output quality:** There appears to be a discrepancy between the amount of time invested and the quality or specificity of the outputs (i.e., the actions).	Process; Content (Actions)	Efficiency
#2	**Level of detail vs newness:** It appears that the mappings helped to increase the level of detail, i.e., to produce a deeper understanding of the use cases, but it is not clear whether it necessarily managed to create many *new* insights.	Process; Content	Level of Detail
#3	**Trade-off between system perspective and actionability:** There appears to be a disconnect between keeping a systems perspective and developing actionable steps for specific stakeholders. Whenever broader themes surface, such as regulation, it becomes hard to formulate objectives or steps to take for a specific stakeholder.	Content (Actions)	Ease of Use; Operationality
#4	**Lack of integration of the *Generate Actions* questions:** Participants had a hard time to engage with the questions in the *Generate Actions* section. These questions are based on the circular metabolism factors developed in D5.1. It can be observed that the topics of these categories are discussed throughout the conversations for each mapping tasks, yet the specific *Generate Actions* questions are currently hard to integrate – for the participants but also for the facilitators.	Process; Content (Mappings)	Ease of Use
#5	**Balance between detail and clustering for actions:** The clustering of the actions is an important step to condense the actions from the action repositories and to reduce the number of actions. While this process helps to get an overview of the actions, detail is lost in this process, making it hard to work with the condensed actions in the next steps, in particular in assigning responsible stakeholders to the actions.	Process; Content (Actions)	Level of Detail
#6	**Inclusion of actors not participating** In the last step of the action planning process, where participants assign the activities to relevant actors, it happened repeatedly that the action had to be assigned to an actor that was not part of the methodology process. A common example is that of legislators. The question remains on how to address this: do participants of the workshop assign these actions simply to non-participatory actors? Or would it be an option to adapt the actions to an item that can be carried out by the participating actors as support?	Content (Actions)	Completeness; Operationality
#7	**Lack of detail and actionability of action items** The actions developed throughout the process become high-level through the action planning process which results in a lack of precision and actionability and makes it more difficult to assign responsible actors.	Content (Actions)	Level of Detail; Effectiveness
#8	**Lack of use and consistency of *Key Mechanisms*** The methodology foresees that participants define the *Key Mechanisms / Root causes* for each mapping after they have completed the second task, i.e., the analysis. The first observation is that most of the time the key mechanisms were skipped by the participants and only completed upon reminder by the facilitators. Whenever participants did identify the key mechanisms, it appears that it helped them to focus the conversation and to use the key mechanisms in the further mappings. The second observation is that participants framed the key mechanisms differently. While some summarised the previous discussion on barriers and enablers and used it to frame the key mechanisms, others named different (and rather high level) causes that had not been discussed yet.	Process	Ease if Use; Understanability

#9	**Division of steps per mapping tasks** Each mapping tasks consists of three steps: 1) Map, 2) Analyse, and 3) Generate Actions. While the approach is designed that these steps are completed in that order, we observe that these tasks are carried out almost exclusively simultaneously by the participants. For example, the group identifies a barrier, analyses it and then defines an action for it (rather than identifying multiple barriers at the same time, then analysing all of them together and creating actions together). While this was not an issue during these facilitation with small groups (such as the use cases), we foresee that mixing the steps could become an issue when working with larger groups. Additionally, it appears that the mixing of the process steps could cause participants to skip the step of identifying key mechanisms.	Process	Ease of Use; Efficiency
#10	**Reframing and -phrasing of the system environment mapping** The system environment mapping task resulted in many good discussions about items such as regulation, market forces, etc. While the conversations were interesting and fruitful, it was hard to turn these items into actions. We are therefore considering whether it would be helpful to change the framing and phrasing of the system mapping task to mirror more the language of the Positive Tipping Points community. That is, asking: What small things can we do that can trigger a big change?	Design; Content (Actions)	Understandability; Ease of Use
#11	**Redesign of system mapping task** The system mapping task was organised identical to the other mapping tasks, i.e., a visual image of the use was the centre of the mapping visual. Given the systems focus of the task, it was hard to place the post it notes on the canvas in a meaningful spot. Different approaches were tested during the sessions with the use cases, but no satisfying result was reached yet.	Design	Ease of Use; Completeness
#12	**Providing support for future facilitators** The facilitator can have a big impact on the outcome of a workshop. For the methodology developed, we foresee that it will be important for facilitators to stimulate participants to think outside of the box. The facilitator may prompt participants to think about paradoxes and contradictions. To help the facilitator take on that role, it might be helpful to create a separate guide with prompts and input for the facilitator.	Facilitation	Operationality
#13	**Narrowness of information flows** The mapping task that relates to information flows is currently titled "information, data, memory & computation". It is designed to also include topics such as ability to store data (memory) as well as compute for different purposes. However, it can be observed that the discussions surrounding the information flows did not reach that level of depth and remained on a rather high level about the information flows.	Process; Content (Mapping)	Completeness
#14	**Optimisation of note taking process** During the facilitated sessions on the methodology, one of the researchers from UHAM took the notes in the online facilitation board on behalf of the group. The industry partners were invited to take notes themselves but acted only seldomly upon that invitation. Follow up discussions with the use cases have shown that it can be difficult for the use case members to understand the notes written in retrospective. It should therefore be encouraged that participants write the post it notes in the sessions.	Process; Facilitation	Ease of Use; Operationality
#15	**Shifting the focus of the actions** At times, participants would define actions that they are already doing rather than shifting the focus to actions that still need to be done. This suggests that we need to adjust the framing or phrasing to make clear that we are looking for actions that are not yet done, i.e. the improvement opportunities.	Content (Actions)	Effectiveness; Operationality
#16	**Complexity of value mapping task** We observe that the value mapping tasks is currently too complex or not focused enough. The conversations do not reach a sufficient level of depth and often would not really go beyond financial value. The value mapping task has to be improved in that aspect. Additionally, we sense that the value mapping task currently includes too many icons and tasks.	Design; Content (Mapping)	Ease of Use; Level of Detail

#			
#17	**Lack of differentiation between multiple resource streams** Many of the resource flow mappings of the use cases show that they are considering different kinds of resources, yet the methodology currently does not account for the multiplicity of the resources in its further course.	Process; Content (Mapping)	Level of Detail; Completeness
#18	**Usefulness of pre-mapping images** Each mapping task included a pre-mapping of the respective flow (done in D6.1 and D6.2). After going through the process, we are unsure how helpful the pre-mappings are for participants. This is an important question to answer because not all future participants will have completed pre-mappings beforehand. That means, if the pre-mappings play an important role, we would have to add another pre-step to the methodology in which participants complete a mapping which then serves as the starting point for them to use the methodology.	Design; Process	Ease of Use; Operationality
#19	**Time required to reach action generation** It was observed that a lot of time was spent on the barriers and enablers, leaving a short amount of time for the action generation per mapping task. The question arose how to increase the speed of the process to arrive at the action quicker.	Process	Efficiency

While developing the methodology, some questions remained regarding the action planning task (the second part of the methodology). The researchers designed this part of the methodology with blanks to be filled in by the use cases to gain an understanding of what the industry partners would consider necessary. For example, the prioritisation of the actions included the prioritisation of the actions. Unsure of what the best criteria would be to use for the prioritisation, the researchers left these blank and asked the use cases for the criteria they would choose. Additionally, the researchers facilitated the second part of the methodology in a way, that made it clear to the partners that their input was highly encouraged. Therefore, the following paragraph offers the learnings made throughout the facilitation regarding the action organisation process.

The previous table presents the researchers' general observations concerning the design, process, content, and facilitation of the methodology. While developing the methodology, some questions remained regarding the action planning task, the second part of the methodology. The section was thus with blanks for the use cases to fill in, with the intention to understand what industry partners consider necessary. For example, due to uncertainty about the most suitable criteria for prioritisation, the criteria were not specified beforehand, and partners were asked to specify their preferred criteria. Moreover, the researchers facilitated this part of the methodology in a manner that encouraged partners to contribute their input. The following paragraph now details the insights gained during the facilitation of the action organisation process.

The criteria chosen by the three use cases for the prioritisation of the actions were:
- impact of the action,
- the capability to implement change (i.e., the effort required to realise the action, e.g., human resources, financial resources, etc.),
- ease of eliminating the barriers (relating to the size of the bottlenecks),
- knowledge available regarding the action,
- time scale (i.e., the time required to implement the action),
- the business value the action would add, and
- the complexity that a certain action holds.

The most mentioned criterion was capability (or effort) to implement change. During the prioritisation of actions, two uses also categorised the actions based on different types. One use case distinguished between *operational* and *future/strategic* actions, while another made the distinction between actions that *adapt the existing system to be more circular*, and those that *contribute to a deeper transformation*, thereby supporting the development of a new system. Additionally, one use case suggested shifting from prioritisation on a graph (with criteria on the x and y axes) to utilizing structural questions that can be answered with a yes or no, leading to follow-up questions or actions.

Example questions proposed include: Does the action exist now? Yes/No. Does it require improvement? Yes/No. Proposed example questions included: "Does the action currently exist? Yes/No" and "Does it require improvement? Yes/No." This suggestion offers potential as such structural questions could facilitate the transfer of knowledge for ontology development.

As a last step, observations were noted regarding the fit of the actions created through the Multi-Flow Method with the Circular Metabolism Factors developed in D5.1. It was attempted to allocate all actions to a Circular Metabolism Factor, and where possible to one of the Circular Enablers or the Implementation Actions. We conclude that the majority of all actions relate to the three levels of principles of the Circularity Design Framework. Only 11 actions were not clearly allocatable (Figure 9). While we acknowledge that further work is required to advance the factors, the fit of the actions and the work done in D5.1 underlines the relevance and applicability of the Circularity Design Framework in guiding the development of circular value chains.

Figure 9 Allocation of Multi-Flow Method actions to Circularity Design Framework (D5.1)

The general observations made by the researchers already point to improvement areas for the Multi-Flow Method. These will be further specified in the list of improvement opportunities in Chapter 3.3.3.

2 Use case specific observations

The researchers made observations regarding the engagement of each use case with the methodology. To put things into perspective, it is helpful to acknowledge the different circumstances of the use cases. We perceive the Construction use case as the most concrete case, i.e., it is organised around a concrete product case and the partners involved in the project play an important role in the supply chain of this product. The Textile use case also centres around an existing product, yet it offers a different perspective as the supply chain for the textile industry is global, yet the recycling is more local. This set up thus brings different insights. The Electronics use case brings a global supply chain perspective to the project. We perceived the sessions with the Electronics partners as very fruitful and contributing a global industry view, rather than focusing on a single

product. This differentiation is important to understand different dynamics in working with the methodology and different outcomes. The following observations were made for each use case:

Construction

The Construction use case emerged as the most diverse and encompassing one. Through the diversity of the different partners involved, Construction was able to cover a wide range of the different mappings. Despite a focus on the re-use scenario, the use case was able to gather insights for a number of different parts of the value chain (e.g., for the producers, the recyclers, the brand, the collectors). Almost the entire first session was spent on the Resource flow mapping task. Although a shorter time period was originally planned, discussions with the use case proved to be generative for nearly 90 minutes. This observation underscores the potential for deeper exploration of the mapping task when time permits. In the same mapping task, the partners also demonstrated an unexpected way of defining the key mechanisms. Instead of identifying the key mechanisms based on the previous discussion around the barriers and enablers, the use case chose to list items that had not been discussed before and showed a higher level of abstraction. In the process of completing the last step of the action planning process, the *now, near, far* task, it showed that the actions developed previously may not be allocatable to a single actor but rather have to be addressed by multiple actors and during different time periods. This observation reveals that the task design may not be appropriate for the complexity that collaboration entails.
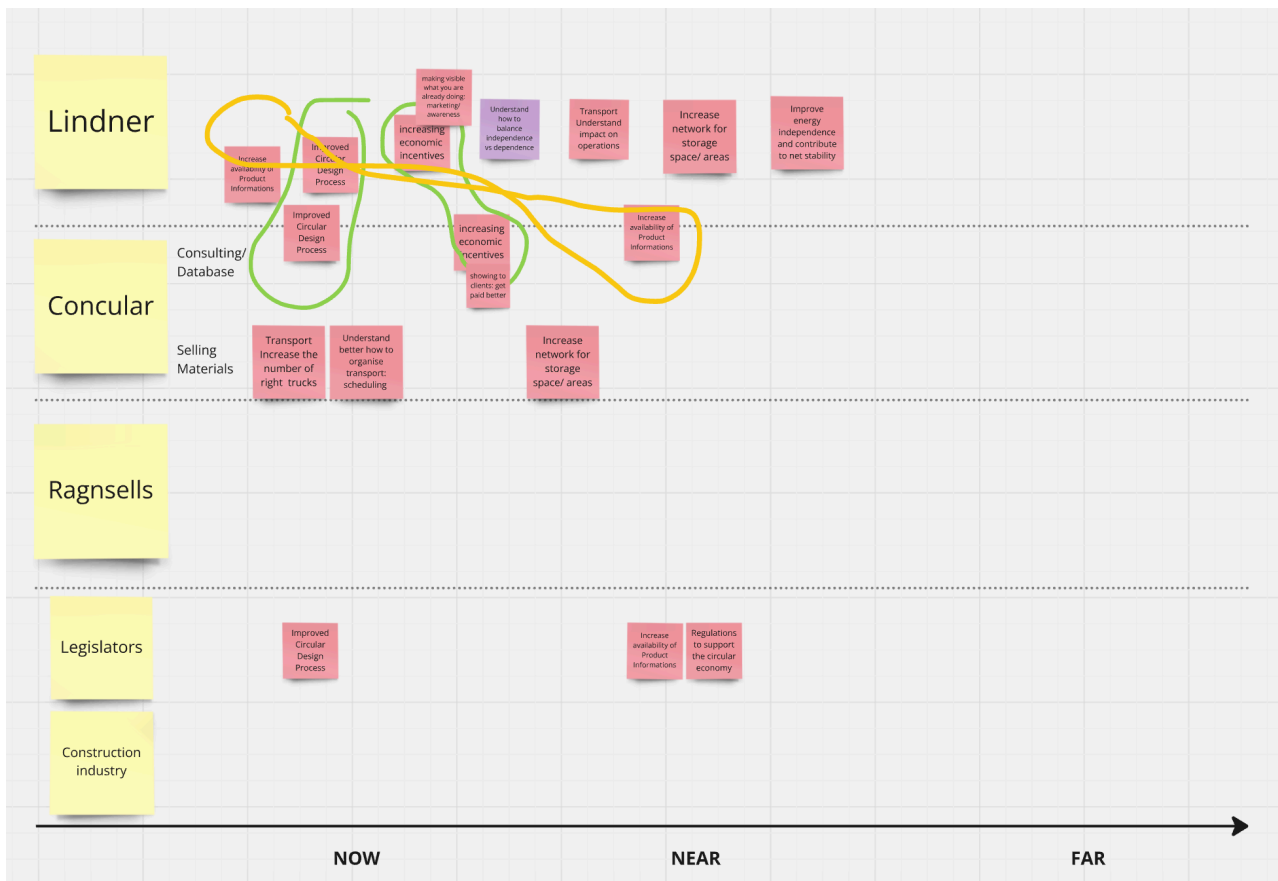
Figure 10 Use Case Specific Observations: Execution of Time planning step by Construction Use Case

Electronics

The current prompts do not encourage an exploration of multiple types of value, which hinders the ability to reach a deeper level of analysis. To enhance the effectiveness of this task, prompts should be revised to facilitate a broader exploration of value dimensions. As the only use case, the partners

took up the task to identify the key mechanisms independently. The use case used the key mechanisms to summarise the previous discussion and to set a focus. The key mechanisms were then used to in other mapping tasks to start the conversation but also to connect it with those of previous mapping tasks. The use of the key mechanisms by the Electronics use case showed that if used, the key mechanisms can support and focus the conversation, as intended by their design. Nevertheless, as experiences with other use cases shows, the key mechanism task requires improvements. In the *action clustering* step, the team showed a different way of organising they action clusters. The partners first clustered the actions (as instructed by the guidelines), and then organised the clusters in a mind map format. This helped to understand and illustrate connections between the actions. Additionally, it helped the use case to identify one key action that will be necessary to shift the entire sector towards more circularity.
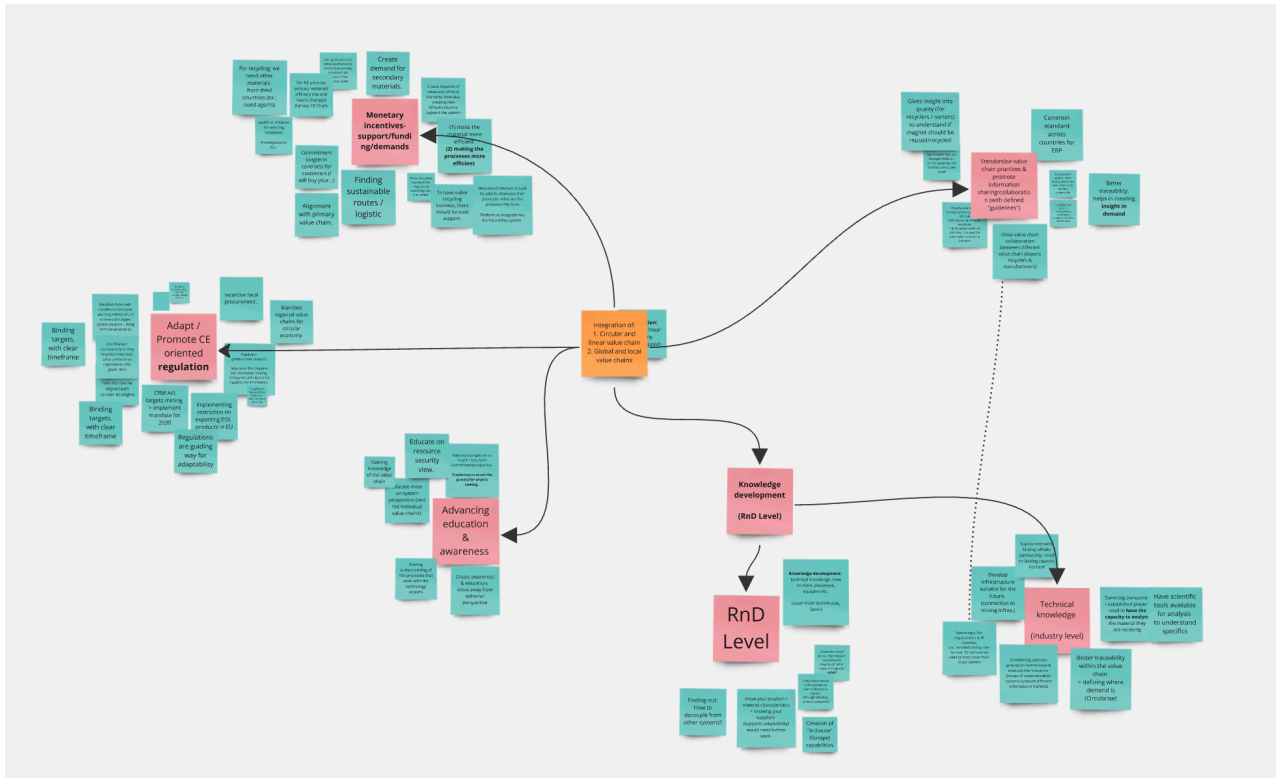
Figure 11 Use Case Specific Observations: Execution of Collect & Cluster step by Electronics Use Case

Regarding the allocation of actions to actors under consideration of the *now, near,* far, the Electronics partners suggested to assign activities to multiple actors and adding specific timing notes for it. For example, they assigned the action "standardise value chain practices" to the traceability providers and indicated "development now" in the now period. They then assigned the same activity to the recyclers and suppliers and indicated "start using them" in the near future. By allocating the action to multiple actors and specifying the timing, the use case managed to keep an overview of the connections.
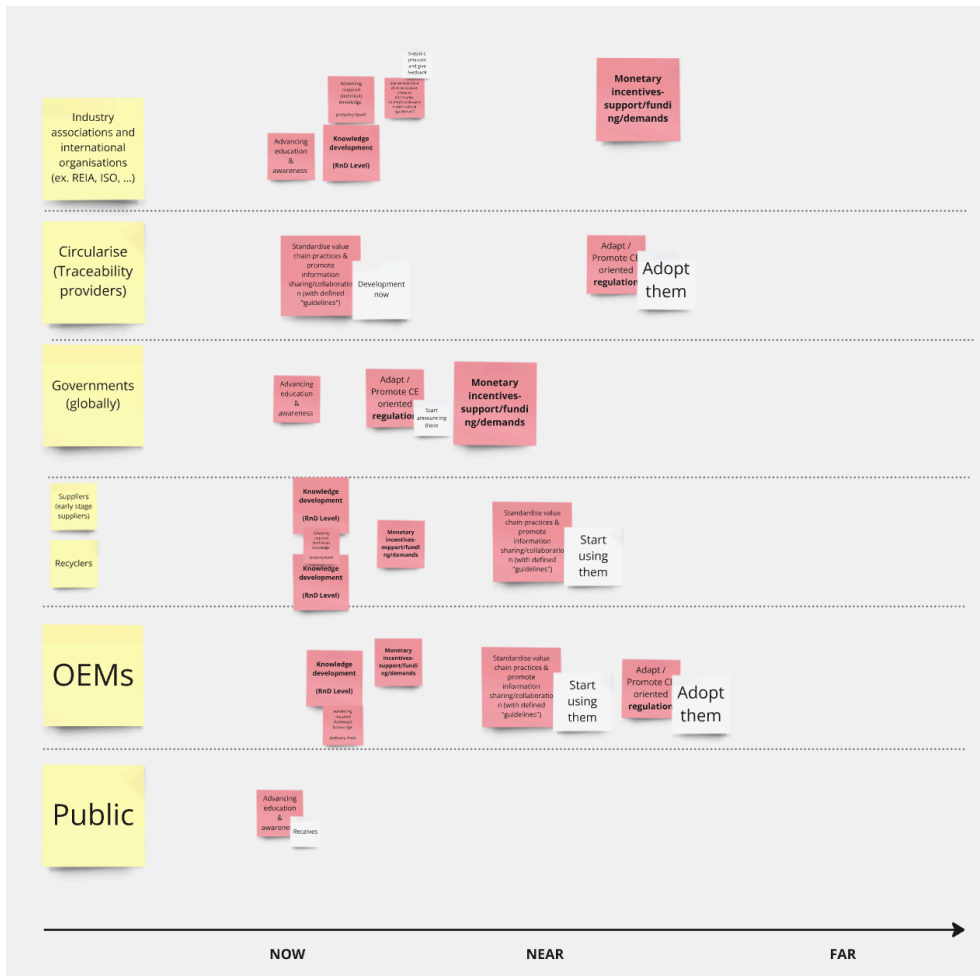
Figure 12 Use Case Specific Observations: Execution of Time planning step by Electronics Use Case

Textile

The discussions in the Textile use case were significantly influenced by one partner who is a material producer in the textile industry. As a result, there is a strong emphasis on the recycling aspects of the case. Many of the actions generated from the discussions reflect initiatives that are already being undertaken in the industry to tackle existing challenges, rather than identifying action items that remain to be implemented to promote greater circularity in the textile sector. This observation suggests that the discussions may need to be guided differently to achieve the desired outcomes. Completing the Systems Environment mapping task with the textile partners highlighted the necessity to modify the design of the Systems Environment, as it continues to be challenging to appropriately categorise the generated notes.

3 Informal Feedback

The informal feedback summarises observations and statements made by participants throughout the facilitated sessions. It includes aspects that participants did or did not like, struggled with or would do differently.

One participant highlighted the benefit of viewing the different flows in isolation. This helped the use case to gain an understanding of shared barriers and opportunities but also to recognise the challenges that other partners are facing. Another participant commented that it was helpful for them to differentiate between different actors and to apply a systems perspective. It was mentioned that taking on the perspective of the other value chain actors is something that they do not do consistently, and that the methodology helped them with this. It was also pointed out that the system

environment mapping gave one of the participants a new perspective that they had not applied before, which resulted in an important revelation for the use case for their particular value chain.

Overall, the few reflections made by the participants during the sessions highlight their appreciation for helping them gain a systems perspective. The participants mention that the methodology helped them to understand barriers and enablers better, yet it was not mentioned that the methodology helped them to identify improvement opportunities or actions they could take. This illustrates the need to refine particularly the second part of the methodology, the action planning process.
Informal Feedback and further reflections by researchers per use case

3.3.2 Formal Feedback

This subchapter summarises the formal feedback collected through the feedback survey distributed amongst the use case partners. Table 8 Key Learnings from Formal Feedback presents the key learnings from the formal feedback by identifying a topic (written in bold) and then allocating the according feedback category to it. Additionally, the evaluation criteria established in DS2 are assigned to the formal feedback topics.

Table 8 Key Learnings from Formal Feedback

#	Key Learnings from Formal Feedback	Feedback Category	Evaluation Criteria established in DS2 (2.5)
#1	**Methodology's purpose is clear, yet not entirely achieved** Participants generally show a good understanding of the purpose of the methodology and can, for the most part, describe the purpose sufficiently in their own words. Helpfulness to identify improvement opportunities: 42,9% somewhat helpful, 14,3% helped quite a bit, 42,9% helped a lot. Helpfulness to gain systems perspective: 57,1% helped quite a bit, 40´2,9% helped a lot.	Design; Content	Effectiveness
#2	**Methodology Design Feedback** Instructions for the mapping task were very clear for 85,7%, and quite clear for 14,3%. (The difference between the different mapping tasks unclear, i.e., on which canvas to place notes that relate to multiple flows). Usefulness of pre-mapping images: 14,3% somewhat useful; 14,3% quite useful; 71,4% very useful.	Design	Understandability; Ease of Use
#3	**Support for integration of Circular Metabolisms Factors** Effectiveness of the *Generate Actions* questions (fit and relevance): 14,3% somewhat effective; 28,6% quite effective; 57,1% very effective.	Design; Content (Mapping)	Effectiveness
#4	**Capabilities of the Methodology** Identify problems: 14,3% somewhat effective 42,9% quite effective; 42,9% very effective. Understand the perspectives of other value chain actors: very mixed results. From 14,33% not very helpful% to 28,6% for each somewhat helpful, moderately helpful and very helpful. Extend to which the method helped identify *new* items (focus on newness): 20% each for slightly, moderately, somewhat; 40% for very much so. Helpful to organise thoughts: 28,6% somewhat helpful; 71,4% very helpful.	Content	Effectiveness; Operationality

#5	**Analysis of mapping tasks** Most useful mapping task: resource flows 85,7%, value flows 57,1%, information 42,9%, system environment 28,6%. Highlighted that resource flows are most helpful because the most input can be put here and participants feel most comfortable items things here because most relate to materials in a way. System environment to help broaden the knowledge on the subject. Value for understanding the different motivations for changing processes and different "weights" of different aspects, being able to choose which matter. No further important topics/conceptual areas were suggested (upon asking if any were uncovered). It was pointed out that stakeholders not included in the process should be considered more explicitly.	Content (Mappings)	Completeness
#6	**Analysis of action organisation process** Ability to help clarify next steps by mapping task: 14,3% not very helpful; 14,3% slightly helpful; 42,9% somewhat helpful and 28,6% very helpful. Feedback ranges from "process was not quite clear" and "prioritisation was arbitrary" to "good summary of previous steps" and "enabled structing the insights". Maybe not yet helpful/precise enough to implement?	Content (Actions)	Ease of Use; Understandability
#7	**Improvement suggestions** Include more stakeholders. Use methodology for different actors with "same task" to identify steps already done, collaboration potential, and what remains to be done. Reduce time required because 6 hours can be quite intense.	Process	Operationality
#8	**Time intensity compared to output** Time investment justified by the outcomes: 14,3% not very helpful; 14,3% somewhat justified, 14,3% moderately justified; 57,1% for completely justified.	Process	Efficiency
#9	**General feedback about methodology** What did they like: • Bigger picture became clearer; system overview better • Interaction with other stakeholders and understand their perspective • Flows diagrams helpful (visualisation) • Appreciation for different topics • "simplicity and intuitiveness without losing detail" What was difficult for them: • Difficult to create shared understanding / agreement between the different actors due to their different roles in the VC • Hard to think for other stakeholders / to have global overview • Identification of enablers not obvious (unlike barriers)	Process; Content	Ease of Use
#10	**Ability to work independently with methodology** Ability to work with methodology on their own: 71,4% no, 28,6% yes. Feedback: Helpful for facilitator to be there direct the conversation, ask critical questions.	Facilitation	Ease of Use; Understandability
#11	**Future implementation scenarios for methodology** 85,7% could envision working with finalised method in the future. In what scenarios: • In consulting any actor for CE opportunities • For discussions in governmental area • To look for improvement opportunities in other areas • In the sustainability process	Facilitation	Operationality

Based on the formal feedback, it can be summarised, that the methodology demonstrates potential in assisting practitioners to identify improvement opportunities for circular value chains, with many participants finding it beneficial for obtaining a systems perspective and structuring their thoughts. While the overall purpose of the methodology is clear, there are areas where clarity and differentiation between mapping tasks need to be improved. Participants appreciated the pre-mappings and the interaction with other stakeholders of the value chain, which contributed to a

broader understanding of the system. However, challenges persist, including time intensity, achieving a shared understanding among diverse stakeholders, and ensuring independent usability without facilitation. The improvement opportunities resulting from the formal feedback are elaborated on in the next subchapter.

3.3.3   Evaluation Summary

This chapter summarises the conclusions regarding the improvements to be made to the Multi-Flow Method based on the general observations by the researchers and the formal feedback collected. Table 9 presents the improvement areas, highlights what possible improvement suggestions were or are being considered, and finally, what the specific improvement actions are and whether these measures are implemented within the current deliverable or designated as future work.

The three most fundamental changes made to the Multi-Flow Method within Bv2.1 were (highlighted in the table below in grey):
- re-organisation & integration of the Circular metabolism factors within the mapping tasks,
- changing method to be more targeted, through streamlining the mapping tasks, carrying over the key mechanisms from one mapping task to another, and adding an additional step to the *Action Organisation* part of the method, and
- considering whether actions fall within the sphere of influence of actors or exploring ways to bring them into their sphere of influence.
-

Additional minor adjustments made to the method in Bv2.1 include the simplification of the value mapping task and the adaptation of the system environment mapping task. For more detailed information and all other improvement suggestions (including those proposed for further work), refer to Table 9.

Table 9 List of Method Improvement Opportunities

#	Improvement area	[KEEP; DELETE; IMPROVE, ADD]	Improvement suggestions & notes	Area of improvement (Design; process; content; facilitation)	Implementation of improvement in Version B2.1 or B2.2 or B2.3 (direct action or intermediate step)
Overall process & outlook: the principles and goal of the process
#1	Development of Systems Perspective	KEEP	• The participants were able to shift from the single actor perspective to a systems perspective, encouraging them to think differently and take on different perspectives (as confirmed by researchers' observations and formal feedback).	Process; Content	
#2	Structure of Mapping Tasks	KEEP	• Instructions for mapping tasks were clear for the participants. • Nevertheless, consider make phrasing even more precise and potentially condensing some of the questions.	Design	
#3	Inclusion of pre-mappings	KEEP/IMPROVE	• The use cases consider the pre-mappings helpful. What does this mean for actors using the methodology that have not done a pre-mapping? What steps need to be added prior to starting on the methodology?	Process	B2.2: Consider the integration of the Multi-Flow Method into other method steps of *Circularity Thinking*
#4	Discrepancy between time invested and actionable results	IMPROVE	• Condensing the questions/prompts for each mapping task. • Identifying a prioritisation (and critical mass) for the mapping tasks. Allocating more time to the action planning process. • Considering to reduce number of mapping tasks, e.g., by consolidating mapping tasks (i.e., include the system environment and information flows into the other mappings through the inclusion of specific questions for these aspects into the other mappings). *(consider carefully: depth & detail vs time)* • The question remains on how to gain more insight into agency.	Process; Content	B2.3: Focus expert interviews on creating and/or gaining agency for systemic change for the metabolism factors. That is: focus on eliciting what actions are possible to exert influence over the development and/or functioning of the value chain?

#5	Carry-over of root causes from Resources task to other mapping tasks	ADD	• In one of the sessions it was possible to have a focused conversation around the mapping tasks after Resources, because the root causes were carried over. That is: the conversation was focused on what the contributing factors of infrastructure, etc were to these root causes.	Process	B2.1: Include, as a step in the process, after the first Resources task, an evaluation of the root causes – and copy them over to the (newly created) designated spaces in the other mapping tasks for these root causes. The prompt for each of these following tasks then becomes: what are the contributing factors in this area to the existence of these root causes (e.g. constituting barriers & enablers)? Based on these insights additional root causes may still be identified. Action generation follows as usual. This would allow getting to the generating actions part of the process quicker.
#6	Optimisation of note taking process	IMPROVE	• Encouraging participants to write notes themselves or find process to agree more on the notes (without losing too much time during the process). Maybe include this also in guide?	Process	BX: tbd – when tool and method are mature enough for good user and facilitator guide with concise and clear instructions
#7	Accounting for different facilitation settings (group sizes)	ADD	• Maybe prepare a guide / the guide for different sizes of groups. o If above number X, follow step by step approach (to keep all engaged). o If below X, okay to combine the steps. • Acknowledging/being aware that that smaller groups may combine steps is important because then we can/have to guide this to make sure they still include all steps (e.g., don't skip the key mechanisms)	Process; Facilitation	B2.2: Articulate, as part of the next user guide, application scenarios of when best to use the tool and method – and who should be included to get the best results. This should make it more clear to other prospective users when to use the method.
#8	Providing support for facilitators	ADD	• To help the facilitator take on that role, it might be helpful to create a separate guide with prompts and input for the facilitator (relating to paradoxes, contradictions, etc.) • Facilitators need to understand the key mechanisms (connection to systems iceberg models)	Facilitation	B3.0: During the next descriptive cycle, gather feedback on what facilitators may need for effective facilitation and include this in the final guide.

ONTO-DESIDE

Part 1 - The 6 mapping tasks: the process and content for the 6 individual tasks				
#9	Organisation & Integration of the Circular metabolism factors	IMPROVE	• In the formal feedback, participants indicated that the *Generate Actions* questions were relevant for completing the tasks. The researchers' observations were that the topics of D5.1 should be included in the methodology but that the use of the questions was rather difficult during the facilitation process. • The analysis of the circular metabolism factors shows that they are captured in the actions defined by the use cases. That said, the use cases considered the circular factors intuitively in their answers but were hesitant on what to respond when asked directly in form of the *Generate Actions* questions. • Therefore, the circular metabolism factors should be integrated differently in the prompts.	Process; Content	B2.2: Review metabolism factors with this intended use in mind: refine and rearticulate to make MFs both distinct from each other as well as meaningful in a value chain context. Review suggestions and/or iterate/ ideate this with project partners.
#10	Better integration of Key Mechanisms / Root Causes	IMPROVE	• Integrate the key mechanisms/root causes more explicitly into the process and make them useable as the foundation to continue the conversation in other mapping tasks. • Write more explicit steps for them, including how to use them moving forward. • Create spot to place the key mechanisms (similar to action repository) (how would we use it then?)	Process; Content	B2.2: articulate what are good root causes & what are not, with MFs as a basis. B2.3: review root causes in light of expert insights.
#11	Adapting the system environment task	IMPROVE	• change the layout / how to place the notes • Completely reframing it to better reflect the Positive Tipping Points language might require further work beforehand • Changing the focus of the system environment How to increase the relevance of the system environment?	Content (Mapping)	B2.1: more direction provided in this version in the form of 3 circles increasingly further removed from the value chain to represent super-systems, that are to be identified as part of the mapping task (e.g. 3 additional layers) B2.2 & B2.3: tdb – depending on evaluation of the improvements made in B2.1
#12	Address narrowness of information flows	IMPROVE	• Adjust the prompts and add more specific prompts for data, memory, etc. Conversations so far did not include memory and computing (e.g. storing data and being able to interrogate it)	Content (Mapping)	B2.2: in the improved version of the MFs this will be a point of attention: whether and how memory and computing can be made more explicit.
#13	Energy flows	IMPROVE	• Make the energy task more relevant. • Understand better what domain knowledge / expertise must be present to create meaningful Energy flow mapping	Content (Mapping)	B2.2: Consider whether it is the right decision to keep energy flows as a separate flow or if it should it be integrated in other flows.

#				
#14	Simplify the value mapping task	IMPROVE	- Learning from the spring sessions: financial value still at the core of the decisions. It might be a worthwhile idea to start the conversation with discussions on financial value and then explicitly shift the conversation to other forms of value. - Potentially the Bv1 approach was too undefined/open to encourage focused conversations. - Continue to include the alignment of goals of actors. - Possible questions: - Financial value: who creates and why? Who pays and why? Who captures and how? - Environmental value: who creates (what is their cost and investment?) and captures it? - What other benefits / value can the system create / offer? And who creates and captures it? - Find a way to further include the systems thinking language into the mapping tool (e.g., attractor). - Reduce the number of items and icons in the mapping task.	Content (Mapping)	B2.1: refocus the conversation by implementing specific differentiation between financial value, environmental value, and other value. Focus the question prompts around who creates (& why), who pays or invests (& why) and who captures these value types (& how) – and to what degree those answers are coherent or consistent – and how this drives the behaviour of the system as a whole (e.g. does the (mis)alignment of incentives cause a problem or barrier?). B2.2 & B2.3: understand & integrate better how to uncover and provide insight into how value and incentives create behavioural responses of actors that influence the system behaviour as whole (e.g. how to also bring carrot & stick dynamics to the forefront)? Use partner discussion & feedback, as well as expert insights for this.
	PART 2 - Action planning: collecting, refining and prioritising actions to arrive at improvement opportunities for specific actors				
#15	Producing detailed items and maintaining level of detail even during condensing steps	IMPROVE	The actions are produced for each mapping task. Then, during the Clustering step, they are condensed in order to prioritise them. As a consequence, detail gets lost in the reductionist step which impedes the actionability of the action items.	Content	B2.1: it is expected that the actions will be more concrete if the root causes are integrated in the process (see above #10). In addition, the process is given an additional step in the form of *Refinement* of actions, which includes the consideration whether actions are within or outside the sphere of influence.
#16	Sphere of influence	ADD	During two of the sessions, actions were split into the operational and the longer term, more strategic and typically higher level actions – typically also more difficult to address. The participants found it easier to relate to the operational actions, but the question around how the sphere of influence can be expanded or how these actions can be brought within it is a valid one from a systems change perspective and therefore needs to be included in the next version of the method.	Content (Actions)	B2.1: The method for the prioritisation will be amended to include a step where the question is explicitly asked: how can these actions be brought within the sphere of influence (broaden sphere or move actions within it)? (E.g. will these actions happen otherwise?)

ONTO-DESIDE

| #17 | Inclusion of actions for/ by actors not participating in the mapping process | ADD | • Some of the actions defined in the process were connected to actors that did not take part in the process.
 • Two ways of addressing this:
    ○ adapt the actions to an item that can be carried out by the participating actors as support
 • create a space for actions that are outside of the Sphere of Influence of the participating actors (maybe also include a separate space for "follow up" actions > those that require the inclusion of other actors) | Content (Actions) | B2.1: Addition of a step, where actions currently unassigned to a specific actor are discussed: is an actor missing from the process so far, or does a new entity need to be created to facilitate leadership or ownership of an issue. |

4   Multi-Flow Value Chain Method: further development

The first chapter of Section 4 provides the results of the second prescriptive stage (PS2), i.e., the second Version of the Multi-Flow Method, named Beta 2.1 (Bv2.1). The second chapter outlines suggestions and necessary steps to address the remaining improvement opportunities.

4.1   PS2 – Method Version Beta 2.1

The first version of the Multi-Flow Method (Bv1) was detailed in Chapter 3.2. Adjustments to the method's design and process were made based on the feedback received, while the core purpose remains unchanged. Consequently, the description of the method in Section 4 emphasises the improvements implemented and does not cover the Method Purpose and Prior Work in this chapter. The method description begins with an overview of the additions and modifications made to the method, followed by a more detailed explanation of Part 1 and Part 2. A comprehensive description of the method can be found in Appendix 6, and a guide for participants to use independently is presented in Appendix 7. The facilitation guide will undergo further development as part of both the remainder of WP5 as well as WP7.

4.1.1   Bv2.1– Method Overview

The general process of the Multi-Flow Method remains the same (Figure 13). Self-facilitated participants begin their method journey by accessing instructions and background information (top left corner of the Miro board).
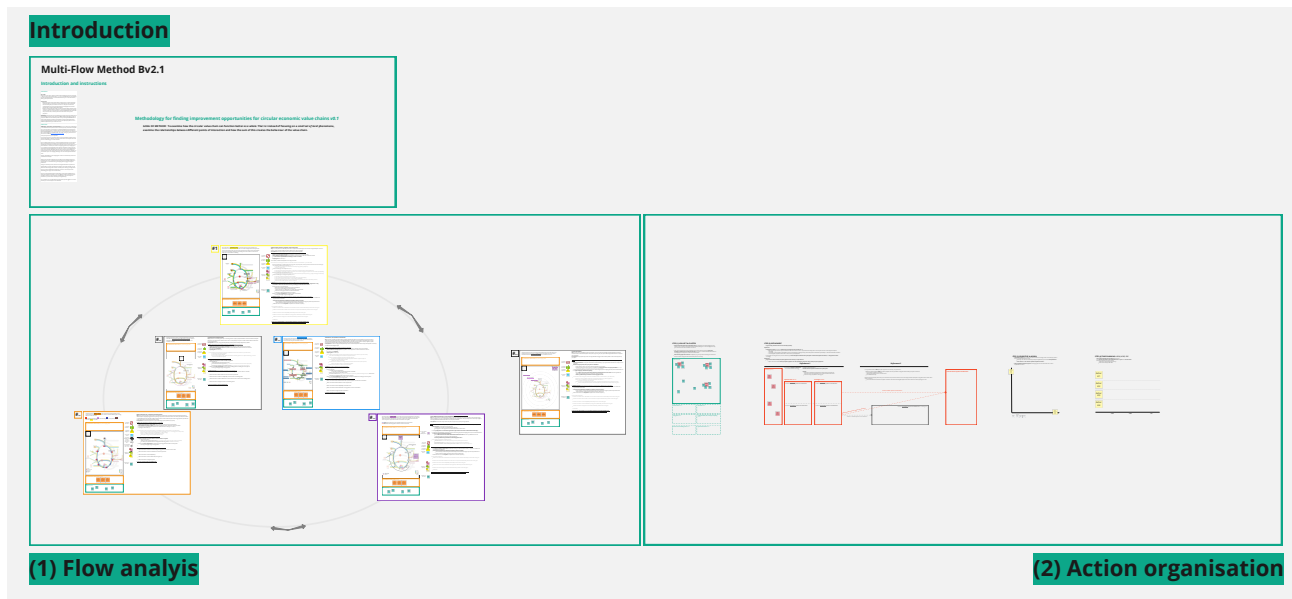
Figure 13 Multi-Flow Method (Bv2.1) Overview

While the overall structure of Part 1, the Flow Analysis, remains unchanged, the process of navigating these mapping tasks has been revised, and the mapping tasks have been restructured to put more focus on the development of key mechanisms and root causes. Participants are instructed to begin specifically with the Resource flows mapping (whereas previously it was just advised for them to start with this task) to identify key mechanisms for the resource flows and actions to address these mechanisms. The key mechanisms are then integrated into other mapping tasks to provide more guidance in developing actions items. It is anticipated that this increased emphasis on key mechanisms will 1) enhance the specificity of the action items, and 2) reduce the time needed to

produce these actions. The new process for navigating the mapping tasks is discussed in the following subchapter.

Significant changes have been implemented in Part 2 of the method, the Action Organisation (Figure 14). Most notably, an additional step has been introduced, expanding the process to four steps: 1) Collect and Cluster, 2) Refinement, 3) Prioritisation, and 4) Time planning. The inclusion of the refinement step aims to enhance the specificity of the actions and ensure they are actionable for participants as they move forward. Overall, by streamlining the steps required for each mapping task in Part 1 (and consequently reducing the overall time needed for this section of the method), along with the addition of the refinement step in the second part, it is anticipated that this approach will address the feedback regarding the current outcomes not justifying the time invested.
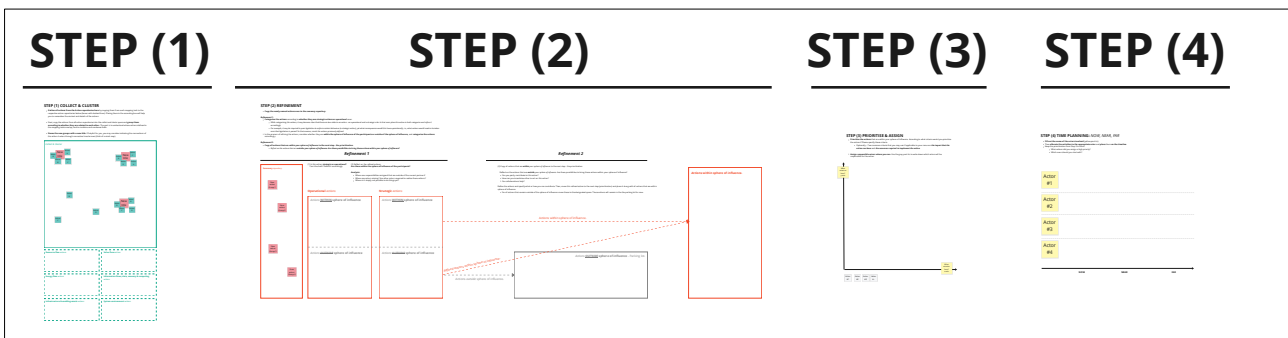
Figure 14 Part 2 (Bv2.1): Overview of *Action planning* steps

4.1.2 Bv2.1 – Part 1: Flow Analysis

The Resource Flows Mapping Task: Re-organisation and Adaptation of Circular Metabolism Factors

The revised version of the Resource Flows mapping task is shown in (Figure 15). In the Multi-Flow Method Bv2.1, this task builds the starting point of the method and is therefore marked as #1 (left corner of the task). The first step of the resource flow task remains the *mapping* – "to create a shared picture of the key barriers and enablers for circular resource flows", i.e., participants are asked to identify key barriers for the respective flow (i.e., what obstacles they have encountered) and what enablers are already in place (i.e., what problems are already solved or what works well at the moment). An adjustment has been made in the structure of the guiding questions provided to facilitate conversations. Based on the Circular Metabolism Factors, five overarching questions are proposed, and the previous prompts are allocated accordingly. To indicate the connection to the respective Circular Metabolism Factor, an abbreviation is included behind every question, e.g., CMF1. The five overarching questions are:

- Are there challenges in understanding the value chain, its participants, and the processes involved? Are there challenges with assessing actions and processes? (CMF 1 + CMF2)
- Are there challenges with adaptation? (CMF 3)
- Are there challenges with collaboration? (CMF 4)
- Are there challenges to manage the system? (CMF 5)

In Bv2.1, the second step of the process is the *analysis* of the key mechanisms/root causes of the challenges identified in the previous mapping step. Participants are asked to summarise the insights on barriers of circular value chains into 2 - 3 key mechanisms/root causes that stand in the way of making the value chain more circular. Question proposed to guide the analysis of the key mechanisms are:

- What are the underlying mechanisms that drive the behaviour?
- Why is this the case? / What is the rationale for this?
- How do other actors or stakeholders in the value chain respond to this?
- What's the underlying mechanism that drives the behaviour?
- How does it influence the distribution of resources?

The third step is to *generate actions* – for "*how to influence the behaviour of the value chain by addressing the key mechanisms"*. To acquire the ability to take action and be able to make the value chain more circular, it is important to address the key mechanisms/root causes. Therefore, the next task is to utilise the key mechanisms to identify the necessary actions to be taken. The question to that the actions should help to answer is: What actions need to be taken to address/overcome/ prevent these key mechanisms? The key mechanisms are to be noted down on orange post its. The fourth step is then to "*copy all key mechanisms to the according repository in the next mapping task"*, while step five is to "*copy all actions from the action repository to the collect & cluster step*".

Figure 15 Resource flows mapping task (Bv2.1)

The act of carrying over the key mechanisms to the next mapping task is one of main adjustments to the mapping approach implemented in method Bv2.1. As a result, the Resource Flows mapping task differs slightly from the other mapping tasks in that the other mapping tasks use the identified key mechanisms as a starting point. The structure of the remaining mapping tasks (i.e., all expect resource flows) are very similarly structured. The mapping task for the Value Flows (Figure 16) is described in the following as an example of all remaining mapping tasks. The value mapping task was chosen because it is the task with the most adjustments made to it (aside from the resource flows) to simplify it.

The Value Flows Mapping Task: Simplification and providing example of a mapping task

Two things were added to the design of the mapping tasks. First, each mapping task now holds a small rectangle in the left corner to note the sequence in which order the mapping tasks have been completed in. Additionally, each mapping task now includes two "Key mechanisms/root causes repositories". The repository located above the pre-mapping image is intended to be used for the key mechanisms defined in previous mapping tasks, i.e., the key mechanisms defined within the resource flows are placed in the upper repository.

The first step is to *map & analyse* – to "create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave". For all mapping tasks (aside from resource flows), this step includes a reflection on the key mechanisms defined in the previous mapping tasks. Participants are asked to reflect on the mapping task-specific elements of the root causes. For example:

- What are the value aspects or elements associated with the root causes?
- Are there any additional factors that contribute to these root causes from a value perspective?

For value specifically, the following prompts were added:

- Financial value: who creates and why? Who pays and why? Who captures and how?
- Environmental value: who creates (what is their cost and investment?) and captures it?
- What other benefits / value can the system create / offer? And who creates and captures it?

In Bv2.1, these prompts were intentionally categorised by different types of value to steer the conversation toward these various forms. Furthermore, it is expected that this simplification will help clarify the value topic while encouraging participants to explore it more deeply.

Additional key mechanisms defined through these prompts are then noted down on additional orange post it notes and placed in the lower action repository. The next step, step two of the mapping task, is to *generate actions* – "to influence the behaviour of the value chain by addressing the key mechanisms". The tasks included in Step 2 are the same as for the resource flow mapping task. That is: to utilise the key mechanisms to identify the necessary actions to be taken, and to identify what actions need to be taken to address/overcome/prevent these key mechanisms. Actions are then noted on teal post-its and placed in the action repository. The following steps 3 and 4 are a repetition from the previous resource mapping task, i.e., to "*copy all key mechanisms to the according repository in the next mapping task" and* to "*copy all actions from the action repository to the collect & cluster step*".

Figure 16 Example of mapping task (Bv2.1) – Value mapping task

Adaptation of the system environment mapping task

The System Environment mapping task (Figure 17) follows the same procedure as outlined for the value flow mapping task above, yet one notable change that was done to this mapping task is the inclusion of three circles increasingly further removed from the value chain to represent super-systems. To enable more focused conversations about the system environment, this mapping tasks includes the following subtasks:

- Define the boundaries: of the system. What defines a useful boundary for your system? Write down the unit of analysis on the grey post it.
- Define the super-system(s) that your system is embedded in.
  - ○ That is: What (or who) is on the other side of the boundary or your system?
- Label the super-systems that the system is embedded in by writing the names on the pink placeholders.

Examples of super-systems may include industries, and national governments & their regulations. The subtasks precede the evaluation and further development of key mechanisms.
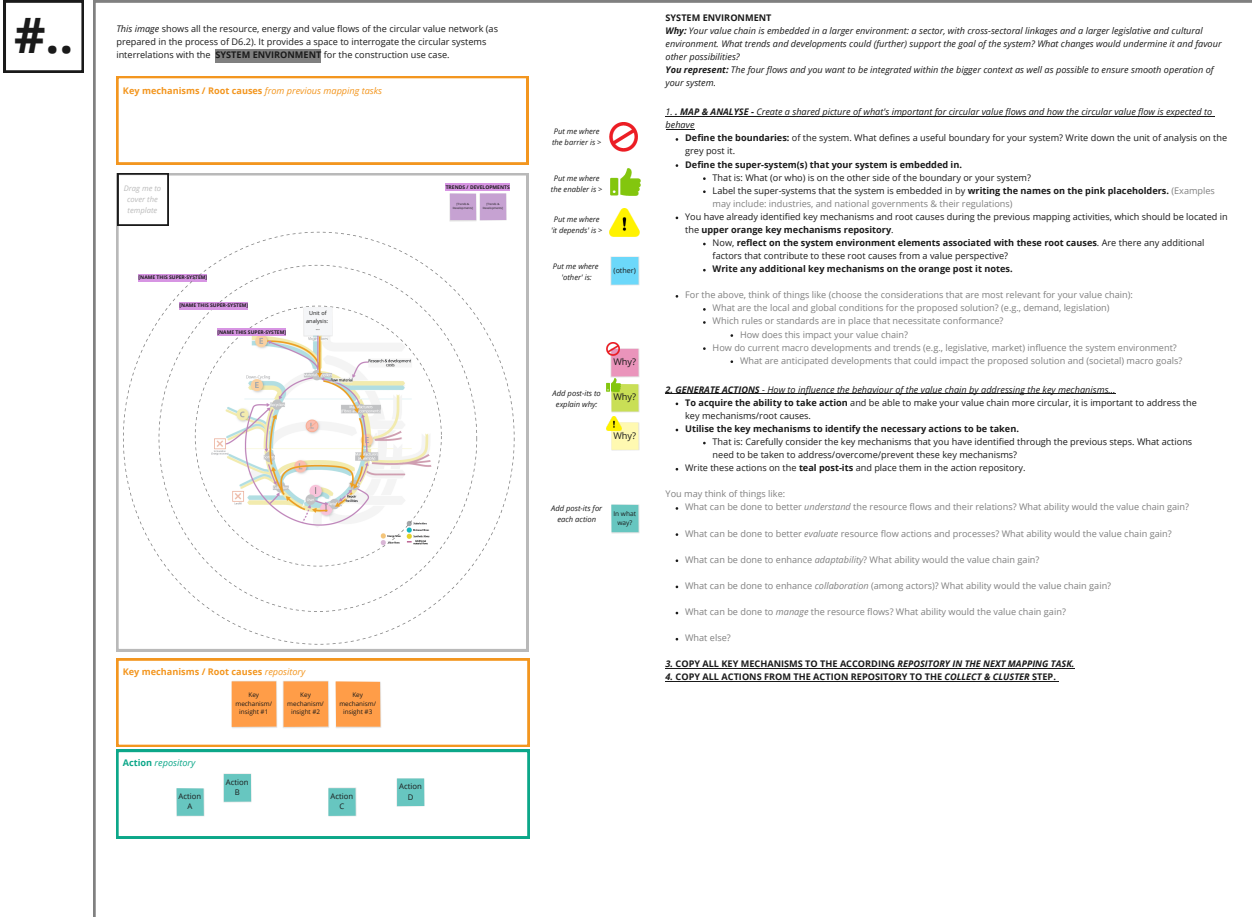
Figure 17 System Environment mapping task (Bv2.1)

4.1.3 Bv2.1 – Part 2: Action Organisation

In Part 2 of method Bv2.1, the Action Organisation, adjustments were made to include four steps instead of the previous three. Each step is discussed individually below, with Step 2, Refinement, receiving the most detailed description due to its addition. The focus for the other three steps will remain on the adjustments that have been made.

Collect & Cluster (Bv2.1)
The goal of the Collect & Cluster step is to condense the created actions and define key actions. In comparison to the first iteration, *action repositories* were added below the clustering space to encourage participants to copy the actions created in the mapping tasks in a more structured way (Figure 18). The idea to include these repositories here arose from the observation that participants struggled to identify during the conversations which mapping task the actions originated from. The action repositories included here thus serve the purpose of helping participants remember the context and details of the actions. The subsequent steps remain the same:

- To copy the actions from all action repositories into the collect and cluster space and group them according to whether they are related to each other
- To name the new groups with a new title.
  - If helpful, participants may consider indicating the connections of the action clusters through connective lines/arrows (similar to a mind map).
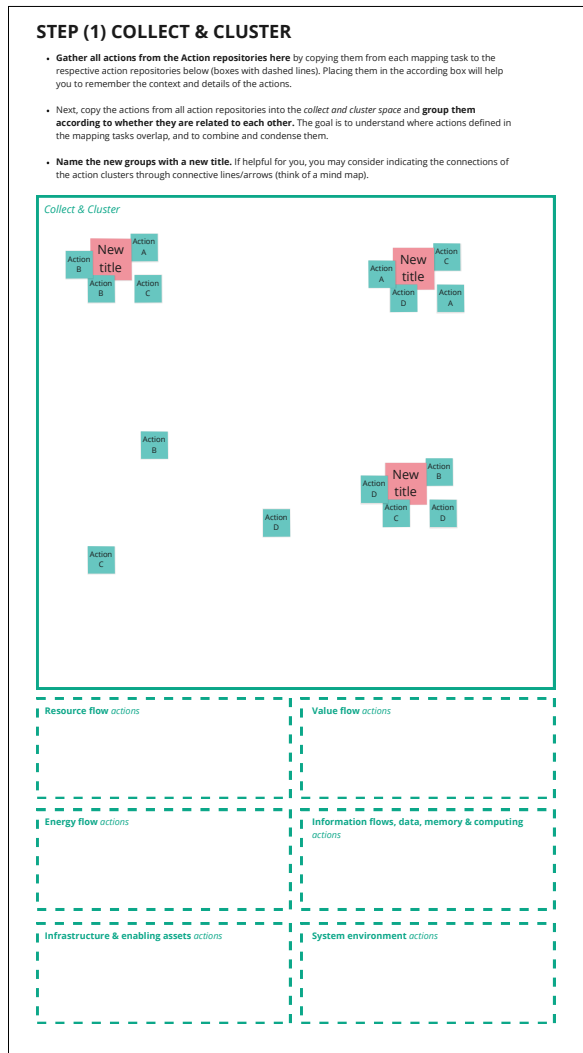
Figure 18 Part 2 (Bv2.1) – Step 1: Collect & Cluster

Refinement (Bv2.1)

The *Refinement* step was added to the Action Organisation part in an effort to develop actions in a more specific and actionable way. The *Refinement* step consists of two subtasks.

Refinement 1

The focus of the first subtask is twofold (Figure 19). First, the task is to differentiate between *strategic* and *operational* actions: 1) actions that are long-term and aimed at achieving broader goals (strategic) versus short-term and focused on immediate tasks (operational). The differentiation was suggested by use case partners during the facilitated sessions, and in the discussions that followed partners reflected more critically on the actions and identified different aspects for some actions. For example, a strategic action may be that regulation is required to overcome a barrier; yet, the operational implication of this action should also be considered – if the regulation would be implemented, what would this mean operationally for partners? The goal of this step is thus to further specify the actions, adding additional ones where necessary.

In the process of refining the actions, participants are asked to consider whether the actions are within their sphere of influence or outside of the sphere of influence, and categorise the actions accordingly – the second subtask of *Refinement 1*.

The following questions are posed to consider:

- Where are responsibilities assigned that are outside of the current partners?
- Where are actors missing? Are other actors required to realise these actions?
- Where is it simply not possible to do things yet?
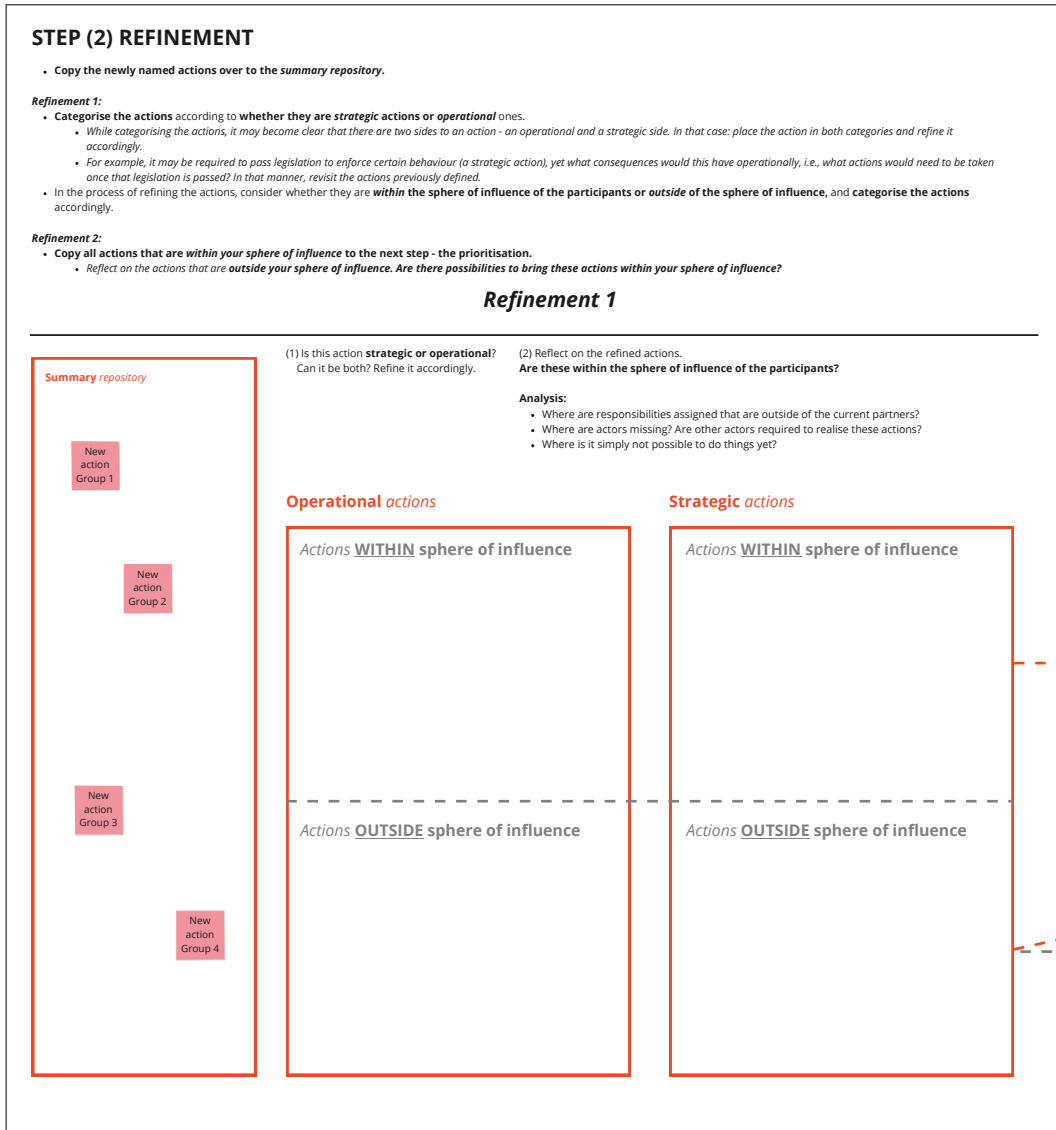
Figure 19 Part 2 (Bv2.1) – Step 2: Refinement 1

Refinement 2

The second refinement step is to consider *if* and *how* actions *outside* of the sphere of influence of partners can be brought *into* the sphere of influence (Figure 20). Therefore, first, all actions that are *within* the sphere of influence should be copied to Step 3, the *Prioritisation*. The according space is indicated in orange. Participants are then asked to reflect on the actions that are outside their sphere of influence and whether possibilities exist to bring these actions within their sphere of influence. The following questions are proposed for an analysis:

- How can you incentivise other to act on this action?
- Can collaborations help?
- Can you partly contribute to this action?

Based on the analysis, actions may be refined or additional ones added. The refined actions are then also moved to the (orange) space dedicated to all actions that are within the sphere of influence. All actions that remain outside of the sphere of influence are moved to the designated space (parking lot).
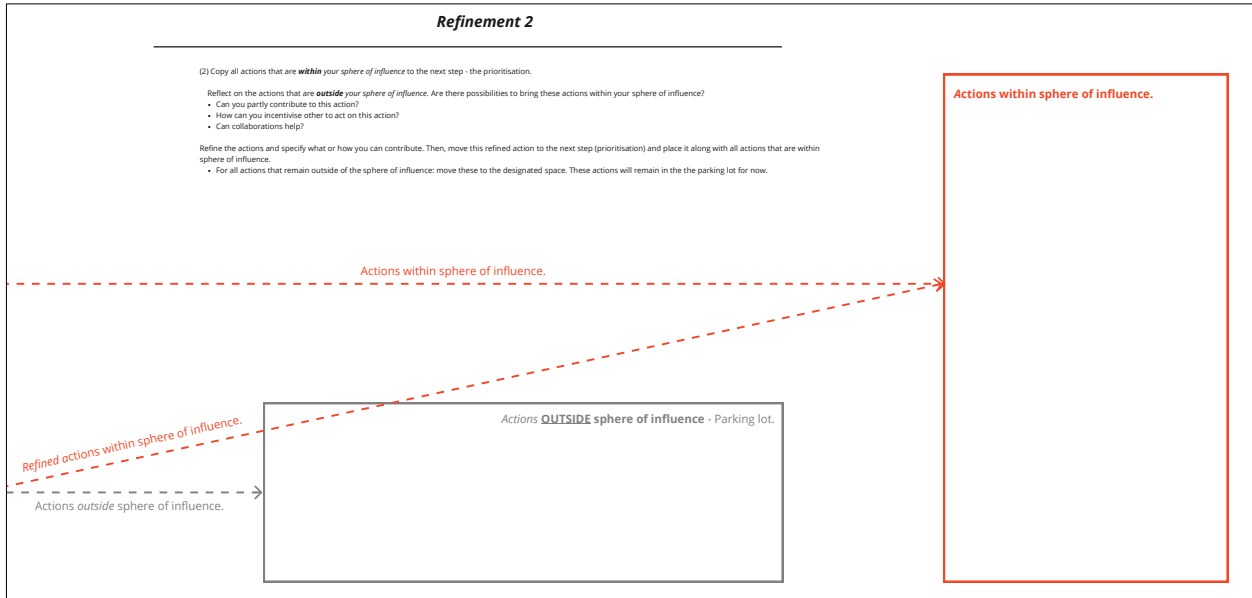
Figure 20 Part 2 (Bv2.1) – Step 2: Refinement 2

Prioritise & Assign (Bv2.1)

The third step of Part 2 is the *Prioritisation* of the actions (Figure 21). Participants will prioritise the actions that are within their sphere of influence according to criteria which they consider the most relevant. Two criteria that have been commonly used by the use case partners, and are thus suggested, are the *impact that the action* can have (or the potential that the action holds to bring about change) and the *resources required* to implement the action (including financial-, human-, and physical resources, knowledge required, etc.). Where possible, actors are already assigned to the actions in this step, using the grey post its.
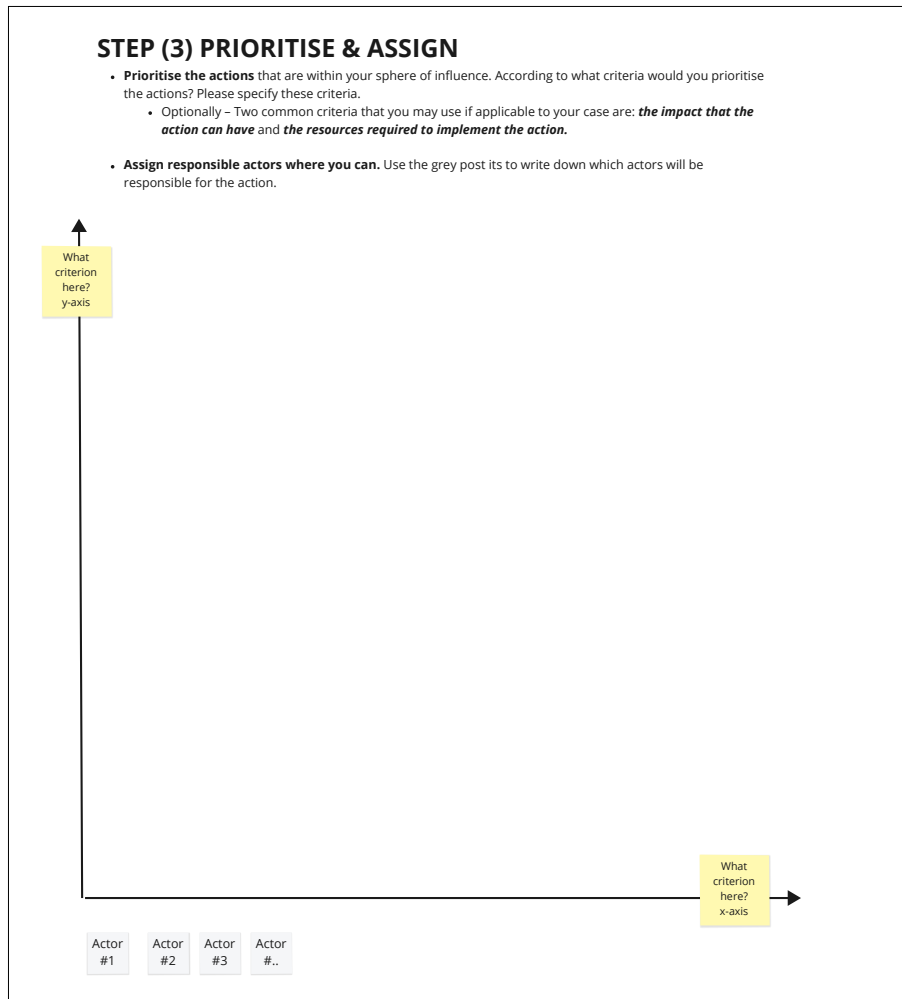
Figure 21 Part 2 (Bv2.1) – Step 3: Prioritisation

Time planning (Bv2.1)

The final step of the action organisation process is the allocation of the actions according to timing and actors (Figure 22). This step remains the same as in the first version. The only addition were questions added to encourage participants to consider the prioritisation from the previous step. The questions include:

- What actions did you assign a high priority?
- Which ones should you start with?
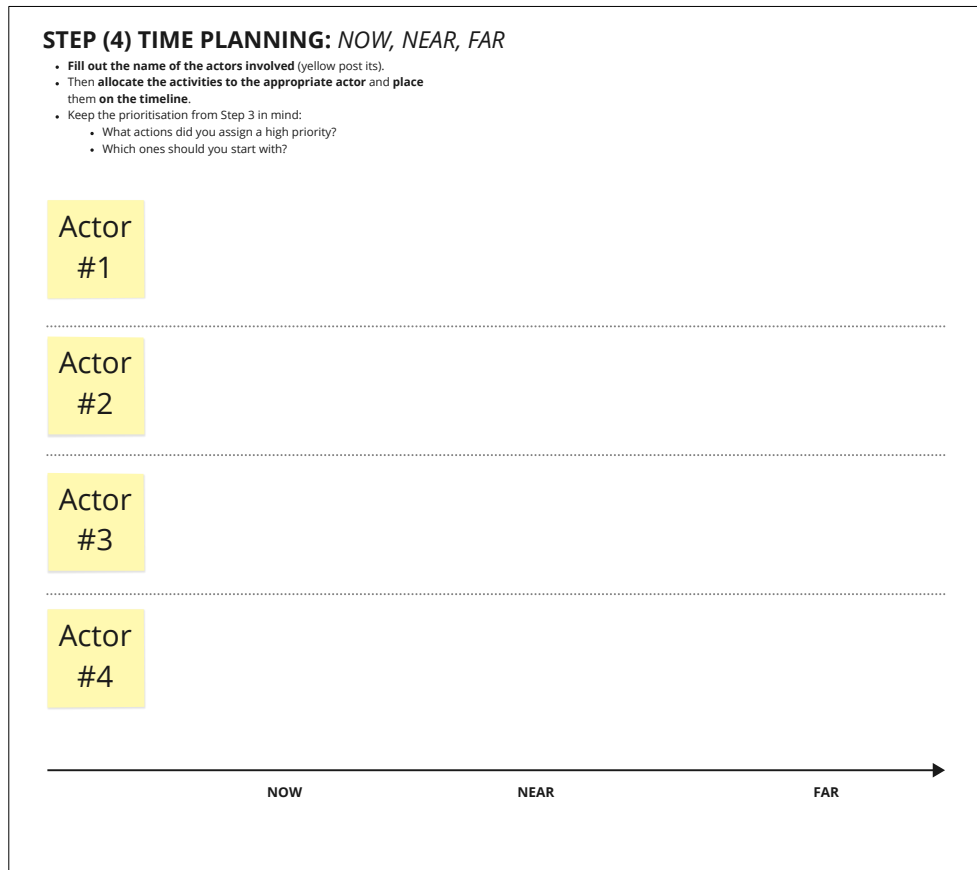
Figure 22 Part 2 (Bv2.1) – Step 4: Time planning

In summary, the present chapter detailed the modifications made to the Multi-Flow Method, describing Version Bv2.1. The improvements were based on the feedback summary presented in Chapter 3.3.3. Open improvement opportunities (for subsequent versions Beta 2.2 and 2.3) remain as indicated in Table 9. Suggestions on how to address these and other next steps planned for the third descriptive stage (DS3) are outlined in the subsequent chapter.

4.2   DS3 – Next Steps

The second version of the method (Bv2.1) was developed in response to feedback from the use case partners. Following the principles of Design Research, this method will be tested and evaluated in the upcoming descriptive phase (DS3) and advanced in the subsequent prescriptive phase (PS3). The current version (Bv2.1) will be presented to the use case partners at the upcoming in-person consortium meeting (09/2024) to solicit their feedback on the adjustments and address any outstanding questions. The consortium meeting will also provide an opportunity to introduce the first facilitation guide and gather feedback on it.

Feedback from the consortium meeting will inform the development of the next version of the Multi-Flow Method, specifically Version Beta 2.2 (Bv2.2). However, additional work is required for the development of Bv2.2. The remaining feedback from the summary table (Table 9) that needs to be integrated includes:

- Develop solutions for incorporating the pre-mapping development into the method process. The use case partners were able to utilise their pre-mappings from D6.1 and D6.2 as initiating points for the method. Partners indicated in the feedback survey that using pre-mappings was helpful. Future participants starting from scratch will lack these pre-mappings, so it needs

to be determined how to integrate such a pre-development step into the method and possibly link it with other tools/steps of the Circularity Thinking toolkit.

- Review Circular metabolism factors with a focus on their intended use: refine and clarify these factors to ensure they are both distinct and meaningful within the context of a value chain. This will involve reviewing suggestions and/or iterating/ideating with project partners.
    - This will necessitate a second phase of a literature review.
- Examine the potential to integrate an updated version of the Circular Metabolism Factors with key mechanisms/root causes to assess whether these root causes effectively contribute to circular value chain development.
- Investigate how memory and computing can be made a more explicit part of the information flows.
- Consider whether maintaining energy flow as a separate mapping task is appropriate or if it requires the involvement of additional relevant stakeholders for this mapping.
- Articulate, as part of the next user guide, application scenarios of when best to use the tool and method – and who should be included to get the best results. This should make it more clear to other prospective users when to use the method.

Addressing the outlined action points will lead to method Bv2.2. There are plans to validate this version through expert interviews, focusing on creating and/or enhancing agency for systemic change regarding metabolism factors. Specifically, the focus will be on identifying what actions can influence the development and/or functioning of the value chain.

Additionally, WP5 is seeking an application case outside the project. The method must be tested with participants who were not involved in the development process (unlike the use case partners) to gain a comprehensive understanding of the necessary adjustments. Furthermore, WP5 is exploring the possibility of conducting a research stay to test and advance the method in practical settings.

5   Conclusion and Implications

The objective of this deliverable was to develop the first iteration of a method and tool focusing on how best to bring a systemic perspective to understanding circular value chains and its constituting flows. That is: to understand the practitioner/business perspective on how to design and develop circular value chains. Specifically:

- How do they view systemic barriers & enablers and their agency to address them;
- What themes or topics are important for them – in past and future developments;
- How does this relate to the different relevant flows, as well as to infrastructure and information flows (MFM).

The goal was to operationalise the Circular Metabolism factors (developed within D5.1) for use in a business context and understand where and how to connect or integrate this with the practitioner perspective. As such, the objective was to both define and further develop the process or steps to take for designing and developing circular value chains – the method, as well as the supporting visual aids and templates – the tools.

The method we developed is referred to as the Multi-Flow Method, which ultimately serves as a foundation for developing a robust and comprehensive approach to support ongoing innovations in the circular economy. The method was developed through a scientific foundation and process (based on Design Research Methodology), whilst working with real world applied cases (the use case of Onto-DESIDE).

The result of this report is the Multi-Flow Method Version Beta 2.1 (Bv2.1). The method consists of two parts: 1) the Flow Analysis, and 2) the Action Organisation. Part 1 includes six individual boards, called mapping tasks, for Resource flows, Value flows, Energy flows, Infrastructure and enabling assets, Information flows, data, memory & computation, and System environment. The purpose of these mapping tasks is to create a shared understanding of barriers and enablers for the respective flows and generating relevant actions to address shortcomings. Part 2 consists of four steps: Collect & Cluster, Refinement, Prioritisation, and Time Planning. The purpose of this subsequent step is to condense and organise the actions in a way that helps participants to take initiative and ownership, but also see where they can collaborate (e.g. have shared responsibilities and mutual interests). Along with the Multi-Flow Method, we have developed a first facilitation guide to enable participants to use the method independently.

5.1   Implications for WP5

After the development of the initial version of the Multi-Flow method (Bv1), feedback was collected and improvement opportunities defined. While it was possible to integrate some improvements already into the Multi-Flow Method Bv2.1, other adjustments require further work (Table 9). We have therefore defined a list of next steps (Chapter 4.2), including: a second phase of literature review to advance the Circular Metabolism Factors, conduct further expert interviews, and the identification of an application case outside the project to test the method with participants who were not involved in the development process. The opportunity to conduct a further research stay is also being explored. The development process will include further iterations of the method before the final version will be submitted through WP5s next and last deliverable D5.3, Multi flow circular value network design & development method Version 2 due M36.

5.2   Implications for other WPs

The work within WP5 has implications, in particular, for the following WPs and the Onto-DESIDE project as a whole:

For WP2 - WP2 is responsible for the development of the ontological and technical project requirements, the integration of the three use cases, and for the generalisation of industry requirements. As part of its work, WP2 sets up the overall research and development methodology applied in the project (T2.2 led by UHAM). The results of the current deliverable have implications for this task in that the insights gained about circular value chain development (which were included within D6.3) may feed into the process to set these requirements, particularly the Circularity Requirements within D2.3. In the next steps of both WP2 and WP5 this cross-fertilisation of these WPs will be further explored.

For WP3 - WP3 develops the ontology methodology (T3.1) in which it combines the requirements of industry partners and the methodological requirements for circular value networks brought forward by WP5. The developments of WP5 in form of learnings about circular value chain developments may thus serve as input for WP3. A revised version of the Circularity Design Framework and the Circular Metabolism Factors, to be developed through a second literature review phase, CDF will support the development of ontologies for circular value networks. WP5 will articulate for WP3 what is important to pay attention to for the design and operation of circular value networks. Which of the elements of the Circularity Design Framework and the Multi-Flow method, and in what way they will be included in the WP3 ontology will be an ongoing collaborative effort between WP3 and WP5.

For WP7 – WP7 is responsible for the development of training material (Task 7.3 led by UHAM). UHAM has developed a first facilitation guide for the Multi-Flow Method within this current deliverable, thereby feeding into the work to be done in WP7. That is: to develop training material which accommodates different skill levels and target audiences and facilitates self-learning and guided classroom (or remote) training events. Alignment with or links to the other guides or material will need to be explored – also in light of the audience or prospective users of the guides.

References

1. Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

2. Blomsma, F. (2018). Collective 'action recipes' in a circular economy—On waste and resource management frameworks and their role in collective change. *Journal of Cleaner Production*, 969–982. https://doi.org/10.1016/j.jclepro.2018.07.145

3. Vandermaesen, T., & Humphries, R. (2019). *EU Overshoot Day—Living Beyond Nature's Limits (WWF)*. https://www.footprintnetwork.org/content/uploads/2019/05/WWF_GFN_EU_Overshoot_Day _report.pdf

4. Oliveira, M., Miguel, M., van Langen, S. K., Ncube, A., Zucaro, A., Fiorentino, G., Passaro, R., Santagata, R., Coleman, N., Lowe, B. H., Ulgiati, S., & Genovese, A. (2021). Circular Economy and the Transition to a Sustainable Society: Integrated Assessment Methods for a New Paradigm. *Circular Economy and Sustainability*, *1*(1), 99–113. https://doi.org/10.1007/s43615-021-00019-y

5. Blomsma, F., Bauwens, T., Weissbrod, I., & Kirchherr, J. (2022). The 'need for speed': Towards circular disruption—What it is, how to make it happen and how to know it's happening. *Business Strategy and the Environment*, bse.3106. https://doi.org/10.1002/bse.3106

6. Aarikka-Stenroos, L., Chiaroni, D., Kaipainen, J., & Urbinati, A. (2022). Companies' circular business models enabled by supply chain collaborations: An empirical-based framework, synthesis, and research agenda. *Industrial Marketing Management*, *105*, 322–339. https://doi.org/10.1016/j.indmarman.2022.06.015

7. Blomsma, F., Tennant, M., & Ozaki, R. (2022). *Making sense of circular economy: Understanding the progression from idea to action*. 26. https://doi.org/DOI: 10.1002/bse.3107

8. Blomsma, F., & Brennan, G. (2017). The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity: The Emergence of Circular Economy. *Journal of Industrial Ecology*, *21*(3), 603–614. https://doi.org/10.1111/jiec.12603

9. Scheel, C., & Bello, B. (2022). Transforming Linear Production Chains into Circular Value Extended Systems. *Sustainability*, *14*(7), 3726. https://doi.org/10.3390/su14073726

10. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

11. *EU Circular Economy Action Plan*. (n.d.). Circular Economy Action Plan - The EU's New Circular Action Plan Paves the Way for a Cleaner and More Competitive Europe. https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en#documents

12. Beinhocker, E. D. (2007). *The origin of wealth: The radical remaking of economics and what it means for business and society* (reprint). Harvard Business School Press.

13. Smil, V. (2017). *Energy and civilization: A history*. The MIT Press. https://www.jstor.org/stable/j.ctt1pwt6jj

14. Rifkin, J. (2011). *The third industrial revolution: How lateral power is transforming energy, the economy, and the world*. Palgrave Macmillan.

15. Lenton, T. M., Pichler, P.-P., & Weisz, H. (2016). Revolutions in energy input and material cycling in Earth history and human history. *Earth System Dynamics*, *7*(2), 353–370. https://doi.org/10.5194/esd-7-353-2016

16. Christian, D. (2004). *Maps of Time: An Introduction to Big History*. University of California Press. http://www.jstor.org/stable/10.1525/j.ctt1pnwzw

17. Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

18. Pieroni, M. P. P., McAloone, T. C., & Pigosso, D. C. A. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of Cleaner Production*, *215*, 198–216. https://doi.org/10.1016/j.jclepro.2019.01.036

19. Kristoffersen, E., Blomsma, F., Mikalef, P., & Li, J. (2020). The smart circular economy_A digital-enabled circular strategies framework for manufacturing companies. *Journal of Business Research*, 21.

20. Cullen, J. M. (2017). Circular Economy: Theoretical Benchmark or Perpetual Motion Machine?: CE: Theoretical Benchmark or Perpetual Motion Machine? *Journal of Industrial Ecology*, *21*(3), 483–486. https://doi.org/10.1111/jiec.12599

21. Allwood, J. M., Ashby, M. F., Gutowski, T. G., & Worrell, E. (2011). Material efficiency: A white paper. *Resources, Conservation and Recycling*, *55*(3), 362–381. https://doi.org/10.1016/j.resconrec.2010.11.002

22. Bakker, C., Wang, F., Huisman, J., & den Hollander, M. (2014). Products that go round: Exploring product life extension through design. *Journal of Cleaner Production*, *69*, 10–16. https://doi.org/10.1016/j.jclepro.2014.01.028

23. Allwood, J. M., & Cullen, J. M. (2012). *Sustainable Materials: With Both Eyes Open*. UIT Cambridge Ltd.

24. McDonough, W., & Braungart, M. (2013). *The upcycle: Beyond Sustainability—Designing for Abundance.* (First edition). North Point Press.

25. McDonough, W., & Braungart, M. (2002). *Cradle to cradle: Remaking the way we make things* (1st ed). North Point Press.

26. Pauli, G. A. (2010). *The blue economy: 10 years, 100 innovations, 100 million jobs*. Paradigm Publications.

27. *Towards the Circular Economy—Economic and business rationale for an accelerated transition*. (n.d.). Ellen McArthur Foundation. Retrieved 1 April 2023, from https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

28. Shukla, P. R., Skea, J., Reisinger, A., & Slade, R. (n.d.). *Climate Change 2022 Mitigation of Climate Change*.

29. The World Bank. (2022). *Squaring the Circle: Policies from Europe's Circular Economy Transition.* https://www.worldbank.org/en/region/eca/publication/squaring-circle-europe-circular-economy-transition

30. Blessing, L. T. M., Chakrabarti, A., & Blessing, L. T. M. (2009). *DRM, a design research methodology*. Springer.

31. Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*. Wiley&Sons.

32. JONES, P., & Van Ael, K. (2022). *DESIGN JOURNEYS THROUGH COMPLEX SYSTEMS: Practice tools for systemic design*. BIS PUBLISHERS B V.

33. Sonnenberg, C., & Vom Brocke, J. (2012). Evaluations in the Science of the Artificial – Reconsidering the Build-Evaluate Pattern in Design Science Research. In K. Peffers, M. Rothenberger, & B. Kuechler (Eds.), *Design Science Research in Information Systems. Advances in Theory and Practice* (Vol. 7286, pp. 381–397). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-29863-9_28

34. Tuunanen, T., Winter, R., & Vom Brocke, J. (2024). Dealing with Complexity in Design Science Research: A Methodology Using Design Echelons. *MIS Quarterly*, *48*(2), 427–458. https://doi.org/10.25300/MISQ/2023/16700

Appendices

Appendix 1 D5.1 Outcome: The restructured Multi Flow Metabolism

Multi-Flow Metabolism
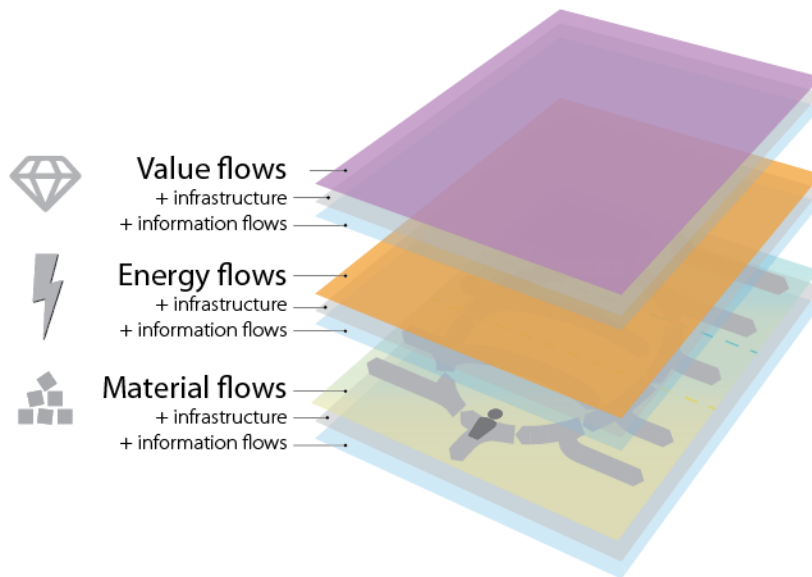
Appendix 2 D5.1 Outcome: The Circularity Design Framework

Circular metabolism factors	Circular Enablers	Implementation Actions		
		Material flows *The ability to:*	Energy flows *The ability to:*	Value flows *The ability to:*
The capacity to understand the system and its relations	The capacity to understand interrelations between processes and actors in the system		• understand all parts of energy (i.e., exergy and anergy) [32,57]	• consider a diverse variety of value forms (incl. economic, environmental, and social) [44,46,54,55] (#4; #5; #6; B; C)
	The capacity to identify and consider all (relevant) system actors	• identify connections by analysing (large amounts of) supply chain data [46]		
	The capacity to consider processes throughout entire life cycle	• collect data along entire supply chain [44] • observe and track materials (in real time) throughout all life cycle phases [45,46]	• collect and analyse large amount of data fast [45,63] • visualise and simulate all processes [46]	
	The capacity to understand interrelations with other systems (at different levels)	• identify connections by analysing (large amounts of) supply chain data [44]	• understand carbon intensity and sustainability of energy sources [51,82] (#5) • visualise and simulate all processes [46]	
The capacity to evaluate actions & processes	The capacity to scope (new) combinations of processes	• analyse the feasibility of resource exchange (#5, #6) • record material specifications and activities in central and standardised unit. [60] • understand the connection of the quality and quantity of flows (#1) • incorporate data from various sources [82] • visually capture processes [32,37]	• trace materials back to their origin to evaluate energy consumption [64] • identify energy requirements of rebound effects from material flows [49] • consider alternatives for achieving efficiency [63] • forecast energy demand and supply [51] • assess technical feasibility [37]	• evaluate the economic feasibility of material and energy strategies [37] • account for social and environmental externalities [47] • develop holistic value proposition [9,43,45] • identify activities for value creation, capture and delivery [58] • develop core objectives [58] • understand value created, value destroyed, value missed [58]
	The capacity to understand system barriers and external factors		• consider macro level energy infrastructure and legislature (#1)	
	The capacity to understand the effect of (a set of) actions (on the system)	• understand success factors of exchanges [55] • measure and compare material flows [37] • evaluate direct and indirect effects [83]	• evaluate energy consumption and carbon emissions [49,63] • analyse large amount of data fast [45] • manage the dynamic and complexity of energy data [63] • measure rebound effects [49] (#1) • establish (prompt) feedback structures [63]	• measure economic, environmental and social value each [66] • combine all dimensions of value for a comprehensive evaluation [57] • assess value created, missed, destroyed [58]
The capacity to adapt	The capacity to acquire and share (new) knowledge	• track actions and decisions made by system actors [46]	• collect data during all life cycle phases [51,63] • incentivize the sharing of data [40]	
	The capacity to develop new configurations	• understand the qualities and characteristics of a material (#1; A)	• collect and process dynamic and complex energy data quickly [45,63] • simulate processes to identify efficiency potential [46]	• define different types of value [38] • understand underlying needs and wants [38,83]
The capacity of actors to collaborate	The capacity to work together for a shared goal	• share infrastructure (Hardware and software) [6,37] • align processes [6] (C)	• share infrastructure (Hardware and software) [37] • collaborate for energy recovery [37] • bring together all energy sector stakeholders [51] • share information on energy demand and surplus [37,40]	• collaborate for value (co)creation, value transfer and value capture [6]
	The capacity to integrate (relevant) actors throughout entire process	• incentivize cooperation [84] • establish reciprocal information exchange [64]	• allow and encourage active engagement by users (i.e., prosumers) [51] • collect and provide consumption data during use phase [40]	• include stakeholders during identification of value [9] • integrate stakeholders in evaluation processes [54]
The capacity to manage the system	The capacity to coordinate processes and actors for the benefit of the system	• manage risk in case of exchange failure [37]	• manage energy exchanges decentralised [51,56] • make decisions automatically [56]	• establish shared vision and align objectives [50,71] • ensure that responsibilities and obligations are met [37]
	The capacity to interact and share information with actors in an effective and trustful way	• share information transparently and traceably [51] • standardise material information (C)	• share information transparently and traceably [51,56]	• verify value creation [83]

Appendix 3 Spring session – Categorisation overview of theme development

HOW TO START IT

MINDSET

- CUSTOMER RATIONALE [C; X]
  - What is the rationale of the customer to engage with the proposed solution? [C; X]
  - Does the circular solution change the value proposition for the customer? [X] / Will the circular solution affect the end consumer's purchasing decision? [X]
  - How is the cost benefit relation affected by the circular solution? [C]
  - How can customer's be convinced of the value of the proposed solution? [C]
  - What is the mindset of the actors involved? Are they experienced with circular economic practices? What is their professional background? [C]
  - What is the customer's industry? [C] What is the industry's historical context? [X]
  - What implicit assumptions exist in the industry? [C; X] What are existing best practices? [X]
  - What are external influences? [X]

- COMPANY RATIONALE [C; X]
  - What is the company benefit for realising the proposed circular solution? [C]
  - What are the incentives for implementing the proposed solution? [C; X; E]
- VALUE PROPOSITION [X]
  - How is this solution integrated in your business model? [X] Is this the proposed solution part of the general product value proposition? [X]
  - What is the (sustainability) objective of the proposed solution? [X]

PRACTICALITIES

- PLANNING & SCOPING [C]
  - What is the extent of the problem? How is it measured now? How can progress be measured?
  - Does a general plan for the implementation now, the near future and the distant future and what each period might require? [X]
    - Does the planning include strategies for after use or EoL? What measures are taken to promote circularity even after PoS/after use/after EoL? [T]
  - Does the proposed solution affect your customer segment? Does it/could it open up new markets/new customers? [C]
  - What are the local and global conditions for the proposed solution? If they differ - what are the implications of that? [C]
  - What kind of demand exists for the product? [pull vs push] [C]
  - Does the new solution somehow create a conflict of interest? [C]
  - Considering the circular strategy chosen, were other circular strategies explored in the process that focus on extending the life of products or components? [X]
  - Does the new solution potentially bring additional responsibilities? [E] (e.g., extended producer responsibility)
- KNOWLEDGE/KNOW HOW [X]
  - Could valuable lessons be learned from similar solutions in different settings (countries, economic status, etc.)?
  - Does an unambiguous understanding of goals/regulation etc. exist? (e.g., what is sustainability)
- ORGANISATION [X]
  - What internal departments/partners are involved in the solution development? [X]
  - What company aspects need to be adapted/improved for the implementation (other than overcoming technical barriers)? What investments (human resources, time, finances, etc.) need to be made to realise the proposed solution? [X]
  - (What are relevant compliance items? [X] (currently also in "how to operate")
  - ...
  - How do customers learn about the solution? [C]
- INTERVENTIONS - what interventions exist to to align cost-benefit balance in favour of sustainability and circular economic practices? [here or in how to operate]
  - Will your solution fulfil (sustainability) requirements that can secure external (financial) benefits? (For example, reduced rates for loans or other funds?) [C]
  - What are possible consequences for not meeting (legislative) obligations? [C]
  - Are competitors subject to the same conditions? What does this mean? If not - what consequences could this have? [C]
  - What regulations will apply for the implementation of the proposed solution? What regulations can be expected in the (near) future? [E]
    - Does favourable legislature exist for the implementation of the solution? What is it? If not, what legislature would support the implementation? (What legislature would create incentives?) [T]
  - Do regulations impede the implementation of the proposed solution? [X]

- MARKET CONDITIONS [X]
  - Will the proposed solution be a competitive advantage? How is the market saturation? [X] Are other firms also already doing similar things? [C]
  - How competitive is the market? How competitive is the sector? [X]
  - How can other (global) markets/sectors influence the implementation of the circular solution? [C]
  - How committed are others in the industry to circularity/sustainability? [X]
- DATA AVAILABILITY [C]
  - What are the minimal data requirements to start? [X]
  - Is the required data available? [C; X]
    - If yes, is it being shared with actors who require it? If not, why and who is preventing it? [X]
    - If not - how could a start still be made? [C]

GETTING STARTED [C]

- TECHNICAL ASPECTS [X]
  - Is the proposed solution already technically realisable? [X]
    - If yes - what is delaying the start? [X]
    - If not, what are the specific barriers? Do alternatives to the primary solution exist? [X]
  - Does the proposed solution replace a previous approach? How does the replacement impact the process/the quality? [X]
- STARTING IMPLEMENTATION
  - Do you need others to start with you? [X]
    - Can you start alone? [X]
    - If NOT: Is it wise to start? can you start in another way? [X]
  - Of your proposed solution [C]
    - Can you start with a part of it? (and is there already a business case for this part?) [C]
    - and add other parts of it later? (Can they co-exist?) [C]
  - If barriers exist, how can they be circumvented? [X]
    - What could be (temporary) compromises to get started? [X]
  - ...
- ...
- ...

## HOW TO OPERATE IT

For the crucial hand-over points, determine:
- RESOURCES [C; X]
  - Which function/purpose does the material need to fulfil? [T]
  - Are resources for the solution readily available? [C; X; E]
    - Is material supply high or low? [C]
    - What impacts the resource supply? What could be barriers to it? [T]
  - How is the supply-demand balance/ratio? And what implications does this have? [X]
  - How can you know if the resource is fit-for-purpose/ good quality? [C] / What steps are necessary to ensure the usability of the materials? [X]
    - How can the material be verified/checked? What is necessary to test it? [T]
    - Or is there a degree of flexibility in quality levels? [C]
  - What is the demand for the product? Does the proposed solution affect the demand for the product? [C] (also push/pull)
  - Could the supply - demand ratio benefit from cross-sectoral collaborations? [X]
  - Could materials be sourced from outside the direct value chain? Do other opportunities exist? [C]
  - What could be barriers to using secondary materials? / What difficulties could arise when using secondary materials? [X]
- SUPPLY CHAIN CHARACTERISTICS [X]
  - Where are resources sourced? [X; E; T] Where are other actors/factories etc. located?[X]
    - Depending on that: what other challenges could arise through the external context? [X]
  - Who has power in the supply chain? [X]
  - What is the supply chain length? [X]
  - Is the supply chain diverse? [X; E]
  - How robust is the supply chain? [X] (How can the supply chain be made robust? / How can the supply chain robustness be increased?)
  - How can supply chain resilience be ensured? [C; X]
  - What could be required to share materials/components across industries? How can the proposed solution integrate/keep in mind the compatibility of resource use across industries? [X]
- HOW (logistics?T)
  - What logistical processes are required? [X] (How will the resource get from A to B? [C] (what information is needed?)
  - What logistical processes could be shared/collaborated on? [X]
  - Do enough (transportation) capacities exist to support other processes? [X] (e.g. moving resources from location to another one)
- WHEN ...
  - Is the timing critical in some way? [C]
  - Can (precise) timing make a difference? (e.g., help to save waste?) [T]
- BUFFERS (physical) - storage and timing? [X]
  - can buffers help to link supply and demand (more) smoothly? get the product there when it's needed? [X]
  - what buffers are necessary? when and where in the value chain? [C]
- TIME DELAYS [X]
  - ...
- ORGANISATION [X]
  - KNOWLEDGE/KNOW HOW [X]
    - Does sufficient knowledge exist (within the organisation) to implement the solution? [X]
    - Is external input/consultancy necessary? [X]
    - Are external experts accessible? [X]
    - What information/knowledge needs to be passed on with the product? [X]
    - How can other actors be made aware of the existing knowledge/materials? [X]
  - COMMUNICATION [X]
    - Does communication between different parts of the value chain / the upstream and downstream value chain exist? [X] (Adjust question)
  - ADMINISTRATION [X]
    - What different or additional administrative processes will be required? [X; T] (e.g., for auditing process)
    - Are enough resources available for the execution (also of regulation)? [T]
  - COMPLIANCE [X]
    - What are relevant compliance items? What/Who enforces compliance? [X]
    - What measurable outputs are produced? / How is progress measured? [X]
  - OWNERSHIP
    - With whom will the ownership of the product remain? Are alternative models (such as PSS) possible? [X]

- INCENTIVES PRICING / PRICING (adjust) [X]
  - How is the proposed solution incentivised? [X; T] (relating to prices for resources; reduction of scope 3)
  - Are system incentives aligned (with the dynamics of other systems)? [X] (to avoid unintended consequences)
  - What value can be captured from the proposed solution? / How can value be captured for that proposed solution? [E] (e.g., Price)
- VALUE (FOR FIRM) [T]
  - What different forms of value exist in the value chain (at different points in the value chain)? [C; T] (Maybe connect to the critical hand over points?)
  - What infrastructure is necessary to capture each form of value? [T]
  - What factors reduce or increase value streams? [T] How does the proposed solution impact different value streams? [T]
  - Where / At what point of the VC are value flows lost? [T]
  - Does a shared understanding of value exist? [T] (what is sustainability, what is valuable for the system) (adjust question)
- VALUE PROPOSITION FOR CUSTOMER
  - How can the product value proposition be secured for customers? [X] / How can the risk be reduced for the customer? [C] (e.g., risk reduction through quality standards)
  - What additional services could be necessary or helpful to convince the customer of your product? [X]
- MARKET CONDITIONS
  - What are the conditions/influence factors outside of the main market? / What are the factors influencing the market development? [X]
- INFRASTRUCTURE [C;X]
  - Are necessary infrastructure requirements already existent? [C;X; E]
  - Do they need to be expanded? [C;X; E]
  - Is the existing capacity sufficient? [C; T]
  - Is new infrastructure required? [C;X; E]
  - Can you share infrastructure? [C; X]
  - How does the infrastructure need to be organised? [X; T] (adjust question - connected to: centralised vs decentralised facilities)
  - (How) can infrastructure help to enable economies of scale? [E]
  - Could (temporary) local infrastructure support the implementation? [X]
  - What purpose does the infrastructure serve? [T]
  - What type of infrastructure needs to be available for customers/consumers? [T] (e.g., localised recyclers & collection points)
- INTERVENTIONS - what interventions exist to to align cost-benefit balance in favour of sustainability and circular economic practices?[C]
- OPERATION [C]
  - What is necessary to follow current regulation? What does to enforcement entail? What are possible consequences? [X]
  - What (new) partners/collaborators could be found in geographic proximity? [C]
  - Is it possible to test the solution in a protected space? [C; X] Or try it as a smaller scaled version? [C]
  - When do you need feedback (adopt: what kind of feedback?)? How do you receive it? How do you receive feedback after POS? [C]
  - What steps are necessary after point of sale to ensure circularity? After EoL? [X]
  - What additional services/processes might be necessary due to the change? [X] What additional services can support the proposed solution? What services might support the customer? [X]
  - What capacities are / What infrastructure is necessary to increase self-reliance of the system / reduce dependencies of other systems? [X]
- TRADE-OFFS [X]
  - What are possible trade offs for the chosen processes? [X]
- IMPACTS [X]
  - What additional impacts / implications could the proposed solution bring? [E]
  - What could be impacts from other parts of the (larger) system / from other systems? [E]
- COLLABORATION [X]
  - What collaborations are necessary? [X; E] What forms of focus of collaboration is required? [E] (e.g., local vs global)
  - What processes need to be co-organised? [X]
  - Do other actors from other industries maybe work on something similar? Could a cross sectoral partnership be possible or beneficial? [X]
- CUSTOMER INVOLVEMENT
  - How could customer involvement increase circularity? / At what points could customer involvement improve the circularity/sustainability of the value chain? [X]
  - What is necessary to empower/enable customers and consumers to contribute to the proposed solution/to increasing circularity? [T]
- DATA [C; X]
  - What data is required? In what form? [C; X] What data will be required at what stages of the value chain? [X]
  - Under what circumstances would the necessary data be shared? [X] What are the incentive to share data? [X]
  - How can the quality of the data be ensured? [X]
  - How can data exchange be facilitated? / How can communication between actors be enabled? [X]
    - How can data be passed on to other subsystems? [E]
  - Does standardisation exist for the collection and sharing of data? [E]
- TRANSPARENCY [X]
  - How can supply chain partners, intermediaries, actors be monitored? [X]
  - How can traceability be enabled? [X; E]
- VALIDATION ... [C]
  - What certifications exist for the proposed solution? When and for whom would they be relevant? [C]
    - How do possible certifications (& which?) impact compliance? [C]
    - How do certifications (& which) affect the possibility to close further loops? [C]
  - How can trust be established? [C; X]
    - With collaborators? With customers? With other actors in the value network? [X]

HOW MAKE THE NEXT STEP

- INTEGRATION - Is the proposed solution part of a higher level solution/project? [C]
  - What steps need to be taken to integrate it? [C]
  - How could the proposed solution be connected / How is the existing system connected with / feed into other circular systems? [E]
- DIVERSIFICATION / ALTERNATIVES - Do other solutions exist in parallel? Or are parallel solutions planned in the future? Which alternative solutions could be designed? [X]
  - Do they affect each other? If so, how? [C]
  - Do they complement each other? [C]
  - Can particular resource scarcities be anticipated / be expected? [E]
- SCALABILITY
  - What is necessary to increase the usability of secondary materials in scale? [C]
  - What are enablers to scale technical feasible solutions? [T]
  - Is sufficient capacity available to scale the solution? [C]
- ADAPTABILITY [X]
  - What possible challenges can arise in the future for the proposed solution? In the industry? [X]
  - What preventative steps can be taken to counteract these? [C]
  - What measures are being taken to account for future needs? [E] (e.g., data requirements)
- TECHNICAL ASPECTS [E]
  - Does the design already take into account requirements for circular strategies after the use and EoL? [X]
  - Are enough resources available to scale the solution? [E]
- LONG TERM DEVELOPMENT
  - Is the proposed solution aligned with "the bigger picture"? / Does it contribute to achieving macro goals? / How does or could the proposed solution impact macro developments? (wording?) [C]
  - Are long term measures / regulations in place? [C]
- ...

TRENDS & DEVELOPMENTS

(Have you tried? When will they reach a critical tipping point?)

- MACRO CONDITIONS [C;X]
  - What are current macro legislative developments? [C]
  - What are the development trends of the market? Are there any? What are the prognosis? What are the (forecasted) trends in the global market? [C; X; T]
  - What developments can be anticipated? [C]
  - What are current macro developments? What are (societal) macro goals that could impact the proposed solution? [C]
  - What are legislative/regulatory trends? (does this question fit here/does it need to be here?) [X]
- INDUSTRY TRENDS [C]
  - What constraints exist for the industry? What is limiting your industry? [C]
  - What constraints can be expected? [C]
- SOCIETAL DEVELOPMENTS [X]
  - What are cultural developments? [E] (change wording?)

C = CONSTRUCTION, E = ELECTRONICS, T = TEXTILE, X = AGNOSTIC

Appendix 4 Overview of Method Version Beta 1 (Bv1)

This Appendix includes visuals of the method Bv1 as it was used for the workshops facilitated with the use case in the first prescriptive study stage (June, July and August 2024). The first image gives an overview of the methodology as participants can see it upon arriving at the online facilitation platform.

A – Overview
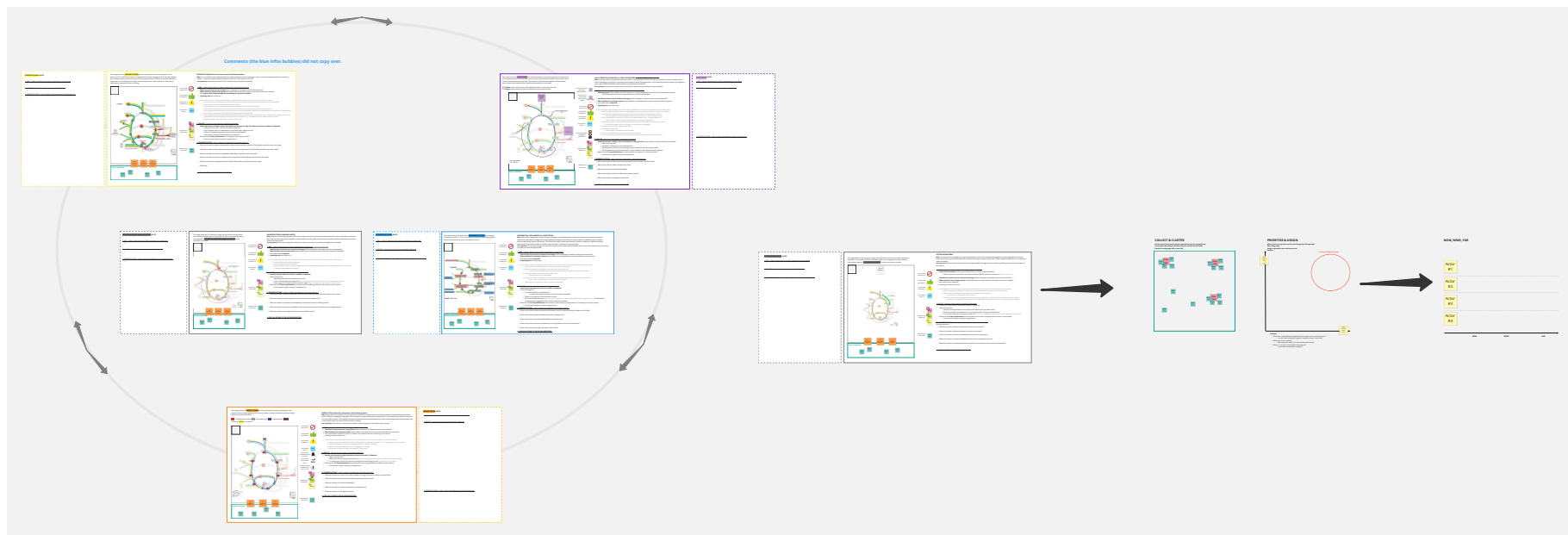
PART 1 – Flow analysis
B – Resource flow mapping task

This image shows the <mark>RESOURCE FLOWS</mark> for the construction use case (as prepared in the process of D6.1 and D6.2). It shows a combination of circular strategies that are already feasible from a technical point of view, yet some of the proposed circular solutions cannot be operated a larger scale, thus standing in the way of a functioning circular value network for the reuse of construction components from a building.

RESOURCE FLOWS: Materials, components and finished products
Why: For circular flows to be realised and function well it is important that the exchanges - when a resource changes hands from one actor to another - function smoothly enabling the system's OUTPUTS to also become its INPUTS.
You represent: the resources and your aim is to flow as long as possible and feasible.

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is: (other)

1. MAP - *Create a shared picture of what's important for circular resource flows*
- **Where are the key barriers located:** what challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, **where does it depend whether something is a barrier or enabler**?
- **Anything else** that comes up...?

- For the above, think of things like (Choose the considerations that are most relevant for your value chain):
  - How well do you understand the flows at the moment (timing, quantity, quality etc)? Where are uncertainties?
  - How well are flows synchronised in time and space?
  - How consistently and reliable do the resources flow within the system? [Supply]
  - How well does the system bounce back from disruptions and maintain flow continuity? [Resilience]
  - How effectively can the system adjust and evolve to accommodate changing flow requirements and conditions? [Adaptability]
  - How ready / prepared is the solution for implementation? [Readiness]
  - How high is the complexity of the supply chain and how does that impact the system? (e.g., supply chain length and diversity)
  - Where does the responsibility for the resources transition? (e.g., Extended producer responsibility schemes)
  - Where does the ownership of the resources transition?

2. ANALYSE - *How the circular system (is expected to) behave(s)*
- **Name the barrier/ enabler/ other and explain on the post its: why the above is a barrier/ enabler/ it depends**
  - Why is this the case? / What is the rationale for this?
  - How do other actors or stakeholders in the value chain respond to this?
  - What's the underlying mechanism that drives the behaviour?
  - How does it influence the distribution of resources?
- What are the **2-3 key mechanisms** for enabling circular resource flows?
  - Sum up your insights using the orange post-its.

Add post-its to explain why: Why? Why? Why?

3. GENERATE ACTIONS - *How to influence the behaviour of the value chain by...*
- What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?
- What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?
- What can be done to enhance *adaptability*? What ability would the value chain gain?
- What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?
- What can be done to *manage* the resource flows? What ability would the value chain gain?
- What else?

Add post-its for each action: In what way?

4. COPY ALL ACTIONS TO THE ACTION REPOSITORY

C – Value flow mapping task

This image shows the VALUE FLOWS for the construction use case (as prepared in the process of D6.2) superimposed on the resource flows. It shows the *financial* value flows of the circular value network and presents *who* pays *who*. This canvas is a space to interrogate the financial flows more closely and to explore other benefits and incentives in the system.

BLUE flows: value flows that go in the opposite direction of the resource flows
RED flows: value flows that go with the direction of the resource flows

VALUE, BENEFITS & INCENTIVES vs COSTS & INVESTMENT <u>and the ability to influence this</u>

Why: For circular flows to be realised and function well it is important that all actors not only act in line with circular principles, but that there is something 'in it' for them - something that outweighs the costs and investments. And, importantly, that the interests of the different actors align WITH EACH OTHER as well as with the circular system AS A WHOLE.

You represent: The resources and you want to be of use to everyone on your journey as long as possible.

1. MAP - *Create a shared picture of what's important for circular value flows*

- **Name the goals**: of the system and of the key actors. Are they aligned with each other? And between the actors?
  - What value does each aim to create? Economic, social, environmental?

- **Identify the key barriers to value exchanges:** what challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, where does **it depend?**
- **Anything else** that comes up?

- For the above, think of things like (Choose the considerations that are most relevant for your value chain):
  - What is the goal of the value chain? (Does agreement exist between different actors on that goal?)
  - How well does the goal of the value chain align with the goals of the individual actors?
    - Do the goals of the actors align with each other? Or does conflict of interest exist?
  - What other benefits are there for the circular value network? (e.g., meeting legislation)
    - What risks are there? (e.g., consequences of not meeting legislation)
  - Who/what creates or adds to the circular value? Who/what subtracts from the circular value?
    - *Use the exchange / plus / minus signs to indicate it on the mapping.*
  - Who pays the costs or makes investments?
  - Incentives versus value
    - What costs are imposed (from outside)?
  - What's the added value compared to linear value chains?
  - Can new markets be created for the value chain (based on the circular solutions chosen

2. ANALYSE *- How the circular system (is expected to) behave(s)*

- **Name the barrier/ enabler/ other and explain on the post its:** why the above is a barrier/ enabler/ it depends?
  - Why is this the case?
  - How does it influence the value distribution?
  - What outcomes will the actors willingly pursue? And which will they actively avoid?
  - Who has the ability influence decisions, control resources, and shape outcomes? [power]
- What are the **2-3 key mechanisms** for value creation and capture in a circular manner?
  - Sum up your insights using the orange post-its.

3. GENERATE ACTIONS *- How to influence the behaviour of the value chain by...*

- What can be done to better *understand* value flows (and its relation to other flows)?

- What can be done to better *evaluate* value flows?

- What can be done to enhance *adaptability*?

- What can be done to enhance *collaboration* (among actors)?

- What can be done to *manage* the value flows?

4. COPY ALL ACTIONS TO THE ACTION REPOSITORY

D – Energy flow mapping task

This image shows the **ENERGY FLOWS** for the construction use case (as prepared in the process of D6.2) superimposed on the resource flows. It shows the different types of energy within the circular value flow.

Red = Production/Processing. **Pink** = Reconditioning; **Blue** = Transportation; **Brown** = Extraction; **Yellow** = Use phase.

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is: (other)

Put me where renewable energies are used >

Put me where fossil fuels are used >

Use me to indicate energy intensity (use 1, 2 or 3) >

Add post-its to explain why: Why? Why? Why?

Add post-its for each action: In what way?

Key mechanism/ insight #1

Key mechanism/ insight #2

Key mechanism/ insight #3

Action repository

Action A   Action B   Action C   Action D

ENERGY FLOWS: Materials, components and finished products
Why: Energy inputs and outputs across the system are essential for moving resources, processing materials, and maintaining operations within the system. Integrating energy flows into the planning is important to ensure that resources can be utilised, processed, and circulated in a sustainable manner. This integration enables a seamless resource transition within the system, where energy inputs drive processes that convert outputs back into inputs, and thus enable circularity.
You represent: The resources and you want to require as little energy input as possible on your journey.

1. MAP - *Create a shared picture of what's important for circular flows*
- **Identify the key barriers to energy flows:** What challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, where does it depend? in which situations can enablers become a challenge or vice-versa?
- Anything else that comes up...?

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - How energy intense are the processes? (For general comparability, place 1, 2 or 3 energy icons on the process)
  - Where is energy lost? Where is energy gained? (e.g., waste to energy)
  - Where are missed opportunities for energy gains / savings?
  - What type of energy is used? (renewable vs. fossil fuels)

2. ANALYSE - *How the circular system (is expected to) behave(s)*
- **Explain on the post its: why the above is a barrier/ enabler/ it depends**
  - Why is this the case?
  - What is the macro energy infrastructure? (e.g., the energy infrastructure in the region where you operate)
  - Is it within your sphere of influence to change the kind of energy used? (renewable vs fossil fuels)
- What are the **2-3 key mechanisms** for enabling (circular) energy flows that enable a circular system?
  - Sum up your insights using the orange post-its.

3. GENERATE ACTIONS - *How to influence the behaviour of the value chain by...*
- What can be done to enhance the understanding of energy flows and its relation to other flows?

- What can be done to enhance the evaluation of actions and processes?

- What can be done to enhance adaptability?

- What can be done to enhance collaboration (among actors)?

- What can be done to manage the system?

4. COPY ALL ACTIONS TO THE ACTION REPOSITORY

E – Infrastructure & enabling assets mapping task

This image shows all the resource, energy and value flows of the circular value network (as prepared in the process of D6.2). It provides a space to interrogate the INFRASTRUCTURE AND ENABLING ASSETS for the construction use case.

INFRASTRUCTURE & ENABLING ASSETS:

Why: Infrastructure and enabling assets refer to those things that are not part of the flows themselves, but that are needed to make flows flow. These are the assets that are needed or make it easier to connect flows from one point to another and that enable the value chain to create and capture value.

You represent: The resource, energy and value flows and you want to flow as smoothly and efficiently as possible .

1. MAP - *Create a shared picture of what's important for circular flows [add timing suggestion]*
- **Identify the key barriers to resource exchanges:** What challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, where does **it depend**?
- **Anything else** that comes up...?

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - Is the infrastructure readily available?
  - Is the required capacity available?
  - Do the circular solutions require additional infrastructure/enabling assets for its implementation? (e.g., does the customer need additional support?)

2. ANALYSE - *How the circular system (is expected to) behave(s)*
- **Identify why the above is a barrier/ enabler/ it depends**
- Think of things like:
  - What purpose does the infrastructure serve?
  - How is the infrastructure organised? (e.g., centralised vs decentralised; shared vs ownership vs public)
  - How long is the infrastructure to remain in place? (e.g., temporary vs. permanent infrastructure)
- What are the **2-3 key mechanisms** of infrastructure & enabling assets for enabling the circular system?
  - Sum up your insights using the orange post-its.

3. GENERATE ACTIONS - *How to influence the behaviour of the value chain by...*
- What can be done to better *understand* infrastructure & enabling assets and their relation to the flows?

- What can be done to better *evaluate* infrastructure & asset requirements?

- What can be done to enhance the *adaptability* of the infrastructure & enabling assets?

- What can be done to enhance *collaboration* for the creation and use of infrastructure & enabling assets?

- What can be done to *manage* infrastructure and enabling assets?

4. COPY ALL ACTIONS TO THE ACTION REPOSITORY

F – Information flows, data, memory and computing mapping task

This image shows a first draft of the **INFORMATION FLOWS** (as prepared in the process of D6.1). That is, it provides a first draft of the data required, where information may act as an enabler or barrier.

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is:

(other)

Add post-its to explain why:

Why?

Why?

Why?

Add post-its for each action

In what way?

Key mechanism/ insight #1

Key mechanism/ insight #2

Key mechanism/ insight #3

Action repository

Action A

Action B

Action C

Action D

INFORMATION, DATA, MEMORY & COMPUTATION

Why: *Information management involves collecting, analysing, and distributing data to ensure all relevant actors have the necessary information. Information management includes effectively handling communication, timely updates, and feedback loops to support decision-making and maintain the system. This includes the ability to store data (memory) as well as compute for different purposes, meaning that one needs the ability to handle and process data - sometimes in large quantities.*

You represent: *The resource, energy and value flows and you want to know what information, data, memory and computation is necessary to enable a smooth and efficient flow.*

1. MAP - Create a shared picture of what's important for circular flows
- **Identify the key barriers to resource exchanges:** What challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, where does **it depend?**
- **Anything else** that comes up?

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - Does sufficient knowledge exist to facilitate the proposed solution?
  - Where is speciality knowledge / particular knowledge required?
    - Is external knowledge required? Are external (experts) available to support the system?
  - Is the necessary information readily accessible.
    - What forms does the data have?
  - If the information is available, is it being effectively shared with relevant actors (who requires it)?
    - How is information sharing / communication handled?
  - What are the incentives for actors to share information?

2. ANALYSE - How the circular system (is expected to) behave(s)
- **Identify why the above is a barrier/ enabler/ it depends**
- Think of things like:
  - Is the data collection standardised?
    - Is information quality assured? Is the information traceable?
  - Where is the timing of the information critical?
  - Do mental models of actors (e.g., personal assumptions, experiences, professional background, etc.) influence their perception and engagement with circular economic practices?
- What are the **2-3 key mechanisms** of information, data, memory & computation for enabling the circular system?
  - Sum up your insights using the orange post-its.

3. GENERATE ACTIONS - How to influence the behaviour of the value chain by...
- What can be done to better *understand* information, data & computation and its relation to the flows?

- What can be done to better *evaluate* information requirements?

- What can be done to enhance *adaptability* of information use?

- What can be done to enhance *collaboration* on the generation and use of information?

- What can be done to *manage* information flows better?

4. COPY ALL ACTIONS TO THE ACTION REPOSITORY

ONTO-DESIDE

G – System environment mapping task

This image shows all the resource, energy and value flows of the circular value network (as prepared in the process of D6.2). It provides a space to interrogate the circular systems interrelations with the **SYSTEM ENVIRONMENT** for the construction use case.

Drag me to cover the template

Unit of analysis: ...

Put me where the barrier is >

🚫

Put me where the enabler is >

👍

Put me where 'it depends' is >

⚠️

Put me where 'other' is:

(other)

Add post-its to explain why:

🚫 Why?

Why?

⚠️ Why?

Add post-its for each action

In what way?

Key mechanism/ insight #1

Key mechanism/ insight #2

Key mechanism/ insight #3

Action repository

Action A

Action B

Action C

Action D

SYSTEM ENVIRONMENT

Why: *Your value chain is embedded in a larger environment: a sector, with cross-sectoral linkages and a larger legislative and cultural environment. What trends and developments could (further) support the goal of the system? What changes would undermine it and favour other possibilities?*

You represent: *The four flows and you want to be integrated within the bigger context as well as possible to ensure smooth operation of your system.*

1. MAP - Create a shared picture of what's important for circular flows
- **Define the boundaries:** of the system. What defines a useful system boundary?
  - What (or who) is on the other side of the boundary? What is the unit of analysis? *(Write it on a post it)*

- **Identify the key barriers to resource exchanges:** What challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, where does it depend?
- Anything else that comes up...?

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - What are the local and global conditions for the proposed solution? (e.g., demand, legislation)
  - Which rules or standards are in place that necessitate conformance?
    - How does this impact your value chain?
  - How do current macro developments and trends (e.g., legislative, market) influence the system environment?
    - What are anticipated developments that could impact the proposed solution and (societal) macro goals?

2. ANALYSE - How the circular system (is expected to) behave(s)
- **Identify why the above is a barrier/ enabler/ it depends**
- Think of things like:
  - What are the implications of the system environment for your value chain?
  - What are possible consequences for not complying with existing rules/standards?
  - Are all actors subject to the same conditions? *(e.g., is the competition subject to the same standards, rules, etc.?)*
- What are the **2-3 key mechanisms** how the system environment interacts/influences the circular system?
  - Sum up your insights using the orange post-its.

3. GENERATE ACTIONS - How to influence the behaviour of the value chain by...
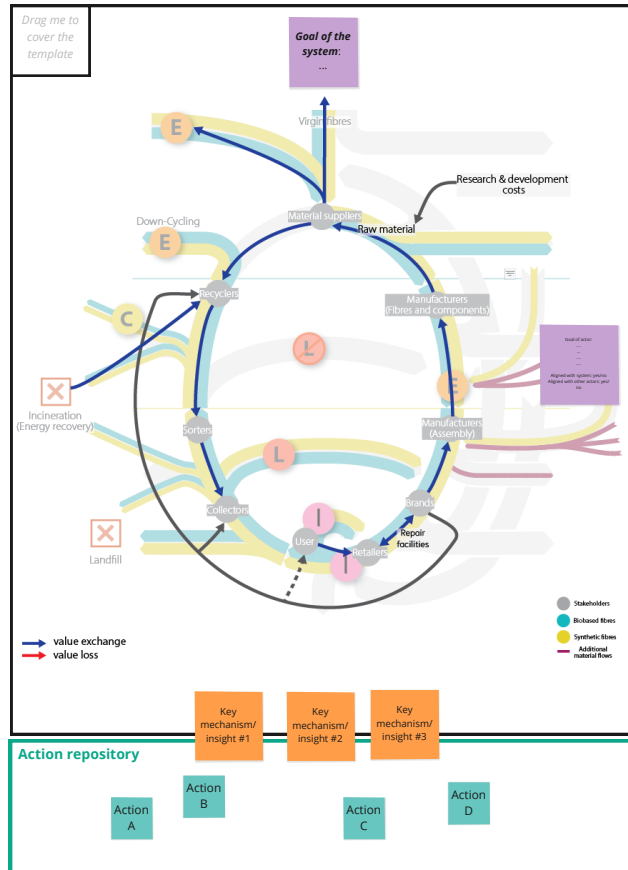Guiding questions:
- What can be done to better *understand* the system environment?

- What can be done to better *evaluate* the system environment?

- What can be done to enhance *adaptability* to the system environment?

- What can be done to enhance *collaboration* with actors in the greater system?

- What can be done to *manage* the interactions with and the influence of the system environment?

4. COPY ALL ACTIONS TO THE ACTION REPOSITORY

COLLECT & CLUSTER

Gather all actions from the Action repositories here by copying them.
Group them according to whether they are related to each other.
Name the new groups with a new title.

Action B
New title
Action A
Action B
Action C

Action A
New title
Action C
Action D
Action A

Action B

New title
Action B
Action D
Action C
Action D

Action D

Action C

I – Prioritisation & Assignment of actors

PRIORITISE & ASSIGN

What criteria can you best use for prioritising the Action groups?
Place the groups.
Assign responsible actors where you can.
Analyse.

What criterion here? y-axis

Actions of Highest Priority

What criterion here? x-axis
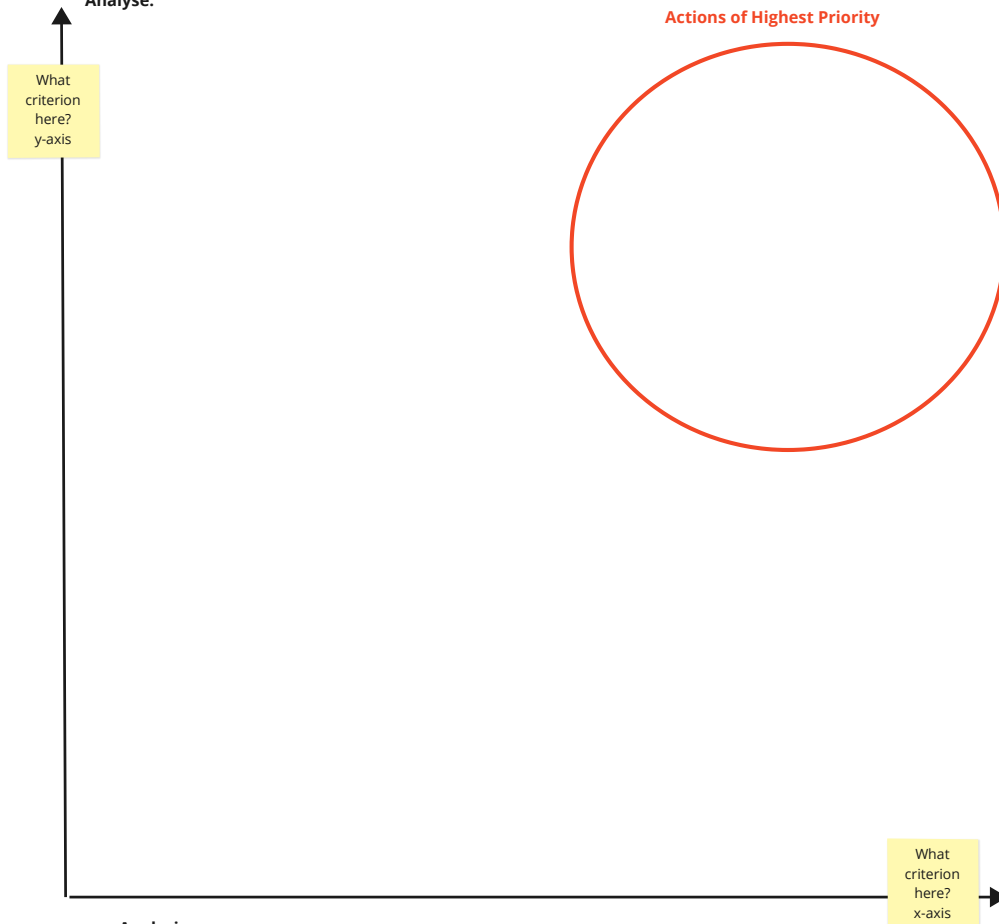
Analysis:

- Where are responsibilities assigned that are outside of the current partners?
  - Can you work with them/ support/ incentivise them in some way?
- Where are actors missing?
  - What does that mean? Can new collaborations help?
- Where is it simply not possible to do things yet?
  - Can this be monitored for changes?

ONTO-DESIDE

J – Allocation of Now, Near or Far Future

NOW, NEAR, FAR

Actor #1

Actor #2

Actor #3

Actor #4

NOW   NEAR   FAR
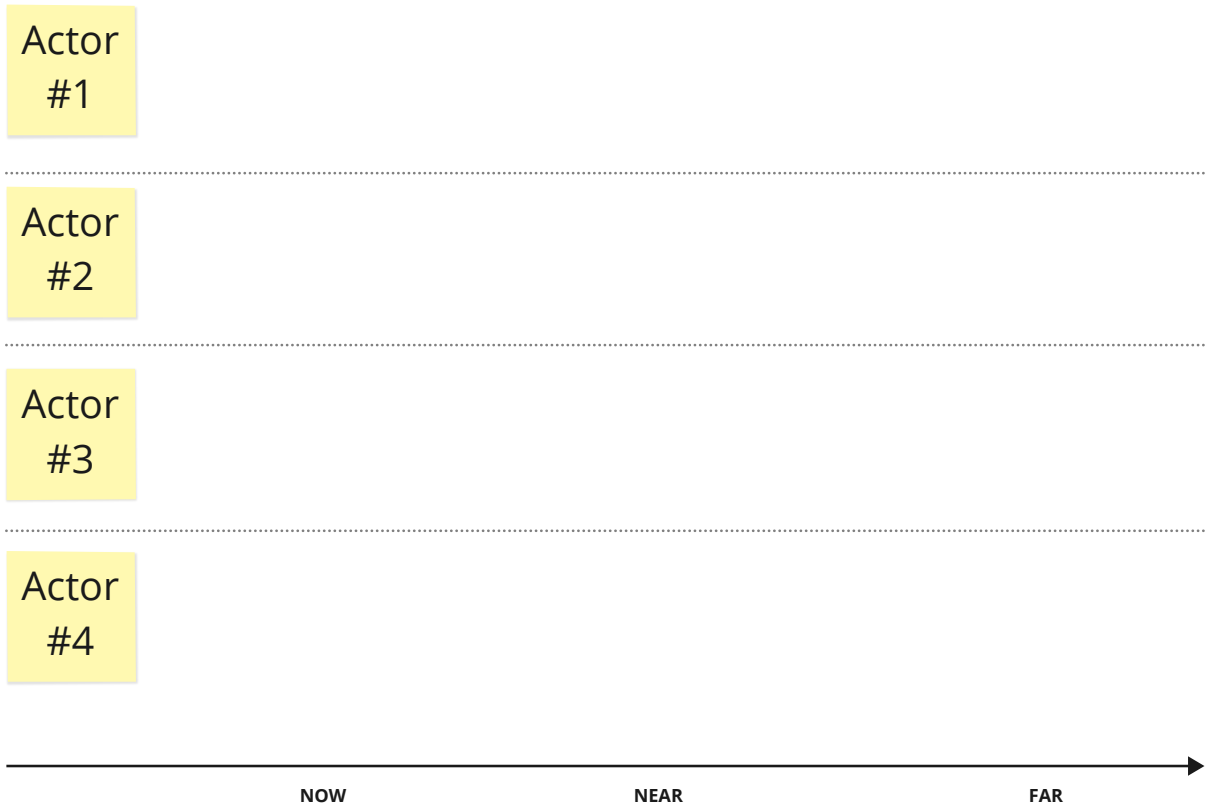
Appendix 5 Formal Feedback: Feedback Survey Questions

This Appendix presents all questions included in the feedback survey distributed among the use case partners.

Section 1 – Purpose of the Methodology

1. What is the purpose of the methodology developed within WP5? Please describe the purpose in your own words based on your understanding from the previous sessions.
   1.1. Open question
2. The methodology is designed to help its user identify improvement opportunities for circular economic value chains. Did the methodology help you and your use case identify improvement opportunities?
   2.1. Scale 1 - 5
3. With the methodology, we want to support you to examine how the circular value chain can function better as a whole. That is: instead of focusing on a small set of local phenomena, examine the relationships between different points of interaction. Did the methodology help you to look at the circular value chain as a whole (rather than from a single actor perspective)?
   3.1. Scale 1 – 5
   3.2. Please provide an explanation for your rating, including the specific number you assigned in the previous question. (Optional)

Section 2 – Methodology Design

4. Were the instructions for each mapping task clear? You may think of: Did you understand what was asked in each mapping task? Did you understand the purpose of the different subsections? Did you understand the difference between the post it colours, icons, etc.? Were the terms and concepts used clear?
   4.1. Scale 1 - 5
5. What was unclear? Use the prompts listed in the previous question as inspiration to answer. Please list the number you assigned in the previous question.
   5.1. Open question
6. How useful were the pre-mapping images derived from previous deliverables in serving as a visual foundation for completing the mapping tasks?
   6.1. Scale 1 – 5
   6.2. Please provide an explanation for your rating, including the specific number you assigned in the previous question. (Optional)
7. How effective did you find the questions in the 'Generate Actions' section regarding their relevance and fit within the overall mapping methodology?
   7.1. Scale 1 – 5

Section 3– Methodology Content

8. How effective did the methodology (i.e., the guiding questions) help you identify problems within the circular value chain?
   8.1. Scale 1 - 5
9. To what extent did the process help you understand the perspectives of other value chain actors (even those who were not part of the exercise)?
   9.1. Scale 1 – 5
   9.2. Please provide an explanation for your rating, including the specific number you assigned in the previous question. (Optional)
10. Select the two mapping tasks that were the most useful to you.
    10.1. Please comment briefly on your choice of the two most useful mapping tasks, and include the name of the two tasks you chose.

11. To what extent did the action definition process (including Collect & Cluster, Prioritize & Assign, and matching actions & actors to Now, Near, or Far) help clarify your next steps?
    11.1.   Scale 1 - 5
    11.2.   Please comment briefly on your rating for the action definition process, and please include the rating you assigned in the previous question.
12. What additional tasks, prompts, or methods would help you explore further and uncover more innovative or valuable insights during the mapping tasks?
Please provide any suggestions on facilitation techniques, additional information, or tools that could enhance the exploration process (and could help you to "dig deeper").
    12.1.   Open Question
13. Do you feel that any important topic/conceptual area was not covered in the methodology?
    13.1.   Yes/No
    13.2.   If yes, please explain which additional topic you believe should be covered in the methodology?
14. To what extent do you feel the methodology helped you identify new actions, connections, or priorities within the system?
    14.1.   Scale 1 - 5
15. To what extent do you feel the methodology helped you organize your thoughts and gain a clearer systems perspective?
    15.1.   Scale 1 -5
    15.2.   Please provide an explanation for your rating, including the specific number you assigned in the previous question. (Optional)
16. To what extent do you feel the methodology helped you organize your thoughts and gain a clearer systems perspective?
    16.1.   Scale 1 – 5
    16.2.   Please provide an explanation for your rating, including the specific number you assigned in the previous question. (Optional)
17. To what extent was the time invested in the methodology (approximately one full day for each use case) justified by the outcomes achieved?
    17.1.   Scale 1 – 5
18. What did you like about the methodology? What was helpful to you?
    18.1.   Open questions
19. What was difficult for you? Where did you struggle with the methodology?
    19.1.   Open questions
20. What are your personal reflections for using the methodology? You may think of: Did it help you understand anything in particular? Did it bring any revelations for you?
    20.1.   Open questions
21. What are your improvement suggestions?
    21.1.   Open questions
22. Do you have any other comments or proposals? What are your improvement suggestions?
    22.1.   Open questions

Section 4 – Facilitation

23. Each use case chose for the working sessions on the methodology to be facilitated by the members of WP5. Do you think you also could have worked on the methodology on your own?
    23.1.   Yes/No
    23.2.   If no: what else would you need to feel comfortable enough to work with the methodology independently?
24. Could you envision using the (finalised) methodology in the future?
    24.1.   Yes/No
    24.2.   If yes, in what scenarios and with whom? If no, why not?

Section 5 – Background Information

25. Which use case do you belong to?
26. How long have you been part of this use case?
27. Each use case met with WP5 at least three times (starting end of June '24) in the process of working with the D5.2 methodology. How many sessions were you able to attend?

Appendix 6 Multi-Flow Method vB2.1
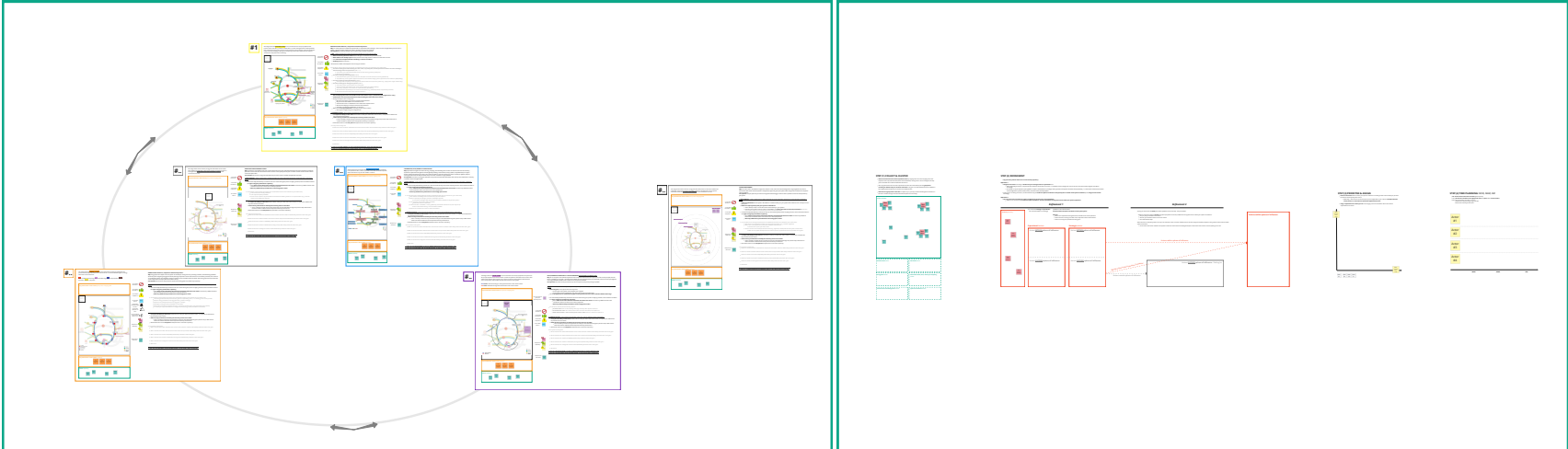
(1) Flow analyis

(2) Action organisation

#1

This image shows the RESOURCE FLOWS for the construction use case (as prepared in the process of D6.1 and D6.2). It shows a combination of circular strategies that are already feasible from a technical point of view, yet some of the proposed circular solutions cannot be operated a larger scale, thus standing in the way of a functioning circular value network for the reuse of construction components from a building.

Drag me to cover the template

Post-industrial waste from other industries

Down-Cycling

Material suppliers

High-grade recycling (Polymer, Rubber, Leather)

Recyclers

Manufacturers (Fibres and components)

Cascaded materials from other supply chains & industries

Recycled ocean-bound bottles

Pine tree resin

Incineration (Energy recovery)

Sorters

Manufacturers (Assembly)

Sole and laces (plastic or biobased) Reinforcements (synthetic or metal)

Additives/ coating chemicals

Landfill

Collectors

Redistribution

Reuse or repair

User

Retailers

Brands

Sewed water (with adhesive waste)

Post consumer waste recycling still problem

"Take Back" Scheme(s) by retailers

Stakeholders
Biobased fibres
Synthetic flows
Additional material flows

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is: (other)

Add post-its to explain why: Why? / Why? / Why?

Add post-its for each action: In what way?

Key mechanisms / Root causes *repository*

Key mechanism/ insight #1 | Key mechanism/ insight #2 | Key mechanism/ insight #3

Action *repository*

Action A | Action B | Action C | Action D

RESOURCE FLOWS: Materials, components and finished products

Why: For circular flows to be realised and function well it is important that the exchanges - when a resource changes hands from one actor to another - function smoothly enabling the system's OUTPUTS to also become its INPUTS.

You represent: the resources and your aim is to flow as long as possible and feasible.

1. MAP - Create a shared picture of the key barriers and enablers for circular resource flows
- **Where are the key barriers located:** what challenges or obstacles have you encountered?
- **What enablers are already in place:** what problems are already solved or what works well at the moment?
- And, **where does it depend whether something is a barrier or enabler**?
- **Anything else** that comes up...?

Use the *barrier*, *enabler* and *it depends* icons to map your answers.

For the above, think of things like (Choose the considerations that are most relevant for your value chain):
- **Are there challenges in understanding the value chain, its participants, and the processes involved? Are there challenges with assessing actions and processes?** (CMF 1 + 2)
  - How well do you understand the flows at the moment (timing, quantity, quality etc)?
  - Where are uncertainties?
- **Are there challenges with adaptation?** (CMF 3)
  - How well does the system bounce back from disruptions and maintain flow continuity? [Resilience]
  - How effectively can the system adjust and evolve to accommodate changing flow requirements and conditions? [Adaptability]
- **Are there challenges with collaboration?** (CMF 4)
  - How high is the complexity of the supply chain and how does that impact the system? (e.g., supply chain length and diversity)
- **Are there challenges to manage the system?** (CMF 5)
  - How well are flows synchronised in time and space?
  - How consistently and reliable do the resources flow within the system? [Supply]
  - How ready / prepared is the solution for implementation? [Readiness]
  - Where does the responsibility for the resources transition? (e.g., Extended producer responsibility schemes)
  - Where does the ownership of the resources transition?

2. ANALYSE - What the key mechanisms / root causes of the challenges for the circular value chain are:
- **After identifying the barriers and enablers of the value chain in step 1), summarise your insights into 2 - 3 key mechanisms / root causes that stand in the way of making the value chain more circular.**
- During the analysis, think of things like:
  - What are the underlying mechanisms that drive the behaviour?
  - Why is this the case? / What is the rationale for this?
  - How do other actors or stakeholders in the value chain respond to this?
  - What's the underlying mechanism that drives the behaviour?
  - How does it influence the distribution of resources?
- What are the **2-3 key mechanisms** for enabling circular resource flows?
  - Sum up your insights using the orange post-its.

3. GENERATE ACTIONS - How to influence the behaviour of the value chain by addressing the key mechanisms...
- **To acquire the ability to take action** and be able to make your value chain more circular, it is important to address the key mechanisms/root causes.
- **Utilise the key mechanisms to identify the necessary actions to be taken.**
  - That is: Carefully consider the key mechanisms that you have identified through the previous steps. What actions need to be taken to address/overcome/prevent these key mechanisms?
- Write these actions on the **teal post-its** and place them in the action repository.

You may think of things like:
- What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?
- What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?
- What can be done to enhance *adaptability*? What ability would the value chain gain?
- What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?
- What can be done to *manage* the resource flows? What ability would the value chain gain?
- What else?

4. COPY ALL KEY MECHANISMS TO THE ACCORDING REPOSITORY IN THE NEXT MAPPING TASK.
5. COPY ALL ACTIONS FROM THE ACTION REPOSITORY TO THE PRIORITISATION STEP.

ONTO-DESIDE

#..

This image shows the **VALUE FLOWS** for the construction use case (as prepared in the process of D6.2) superimposed on the resource flows. It shows the *financial* value flows of the circular value network and presents *who* pays *who*. This canvas is a space to interrogate the financial flows more closely and to explore other benefits and incentives in the system.

BLUE flows: value flows that go in the opposite direction of the resource flows
RED flows: value flows that go with the direction of the resource flows

Key mechanisms / Root causes *from previous mapping tasks*

Use me to name the goals of the system/key actors > � purple▪

Drag me to cover the template

Goal of the system: ...

E Virgin fibres

Research & development costs

Material supplier

Down-Cycling Raw material

E

Recycler Manufacturers (Fibres and components)

C

Incineration (Energy recovery) L

E

Sorters Manufacturer (Assembly)

L

Collectors Brands

User Repair facilities

Landfill Retailers

→ value exchange
→ value loss

Stakeholders
Biobased flows
Synthetic flows
Additional material flows

Put me where the barrier is > 🚫
Put me where the enabler is > 👍
Put me where 'it depends' is > ⚠️
Put me where 'other' is: (other)

Add post-its to explain why: 🚫 Why? / 👍 Why? / ⚠️ Why?

Add post-its for each action In what way?

Key mechanisms / Root causes *repository*

Key mechanism/ insight #1 Key mechanism/ insight #2 Key mechanism/ insight #3

Action *repository*

Action A Action B Action C Action D

VALUE, BENEFITS & INCENTIVES vs COSTS & INVESTMENT **and the ability to influence this**
Why: For circular flows to be realised and function well it is important that all actors not only act in line with circular principles, but that there is something 'in it' for them - something that outweighs the costs and investments. And, importantly, that the interests of the different actors align WITH EACH OTHER as well as with the circular system AS A WHOLE.
You represent: The resources and you want to be of use to everyone on your journey as long as possible.

1. MAP & ANALYSE - *Create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave*
- **Name the goals**: of the system and of the key actors.
  - Are the goals of the system and individual actors aligned?
  - Are the goals of actors aligned with each other? Does conflict of interest exist?
- Use the **purple post its to write down the goals of the system & the actors and to indicate whether these align**.

- You have already identified key mechanisms and root causes during the previous mapping activities, which should be located in the **upper orange key mechanisms repository**.
  - Now, **reflect on the value elements associated with these root causes**. Are there any additional factors that contribute to these root causes from a value perspective?
  - **Write any additional key mechanisms on the orange post it notes.**

- For the above, think about the following aspects:
  - **Financial value:** who creates and why? Who pays and why? Who captures and how?
  - **Environmental value:** who creates (what is their cost and investment?) and captures it?
  - **What other benefits / value can the system create / offer?** And who creates and captures it?

2. GENERATE ACTIONS - *How to influence the behaviour of the value chain by addressing the key mechanisms...*
- **To acquire the ability to take action** and be able to make your value chain more circular, it is important to address the key mechanisms/root causes.
- **Utilise the key mechanisms to identify the necessary actions to be taken.**
  - That is: Carefully consider the key mechanisms that you have identified through the previous steps. What actions need to be taken to address/overcome/prevent these key mechanisms?
- Write these actions on the **teal post-its** and place them in the action repository.

You may think of things like:
- What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?

- What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?

- What can be done to enhance *adaptability*? What ability would the value chain gain?

- What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?

- What can be done to *manage* the resource flows? What ability would the value chain gain?

- What else?

3. COPY ALL KEY MECHANISMS TO THE ACCORDING *REPOSITORY IN THE NEXT MAPPING TASK.*
4. COPY ALL ACTIONS FROM THE ACTION REPOSITORY TO THE *COLLECT AND CLUSTER* **STEP.**

#..

This image shows the ENERGY FLOWS for the construction use case (as prepared in the process of D6.2) superimposed on the resource flows. It shows the different types of energy within the circular value flow.

Red = Production/Processing. Pink = Reconditioning; Blue = Transportation; Brown = Extraction; Yellow = Use phase.

Key mechanisms / Root causes *from previous mapping tasks*
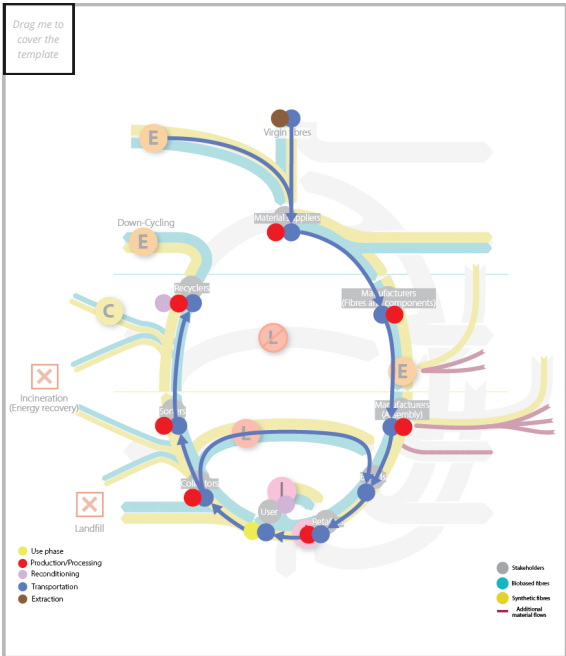
Drag me to cover the template

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is:

Put me where renewable energies are used >

Put me where fossil fuels are used >

Use me to indicate energy intensity (use 1, 2 or 3) >

Add post-its to explain why:

Why?
Why?
Why?

Add post-its for each action

In what way?

Use phase
Production/Processing
Reconditioning
Transportation
Extraction

Stakeholders
Biobased fibres
Synthetic fibres
Additional material flows

Key mechanisms / Root causes *repository*

Key mechanism/ insight #1
Key mechanism/ insight #2
Key mechanism/ insight #3

Action *repository*

Action A
Action B
Action C
Action D

ENERGY FLOWS: Materials, components and finished products
Why: *Energy inputs and outputs across the system are essential for moving resources, processing materials, and maintaining operations within the system. Integrating energy flows into the planning is important to ensure that resources can be utilised, processed, and circulated in a sustainable manner. This integration enables a seamless resource transition within the system, where energy inputs drive processes that convert outputs back into inputs, and thus enable circularity.*
You represent: *The resources and you want to require as little energy input as possible on your journey.*

1. MAP & ANALYSE - Create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave

- You have already identified key mechanisms and root causes during the previous mapping activities, which should be located in the **upper orange key mechanisms repository**.
  - Now, **reflect on the information flow elements associated with these root causes**. Are there any additional factors that contribute to these root causes from a value perspective?
  - **Write any additional key mechanisms on the orange post it notes.**

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - How energy intense are the processes? (For general comparability, place 1, 2 or 3 energy icons on the process)
  - Where is energy lost? Where is energy gained? (e.g., waste to energy)
  - Where are missed opportunities for energy gains / savings?
  - What type of energy is used? (renewable vs. fossil fuels)
  - What is the macro energy infrastructure? (e.g., the energy infrastructure in the region where you operate)
  - Is it within your sphere of influence to change the kind of energy used? (renewable vs fossil fuels)

2. GENERATE ACTIONS - How to influence the behaviour of the value chain by addressing the key mechanisms...
- **To acquire the ability to take action** and be able to make your value chain more circular, it is important to address the key mechanisms/root causes.
- **Utilise the key mechanisms to identify the necessary actions to be taken.**
  - That is: Carefully consider the key mechanisms that you have identified through the previous steps. What actions need to be taken to address/overcome/prevent these key mechanisms?
- Write these actions on the **teal post-its** and place them in the action repository.

You may think of things like:
- What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?

- What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?

- What can be done to enhance *adaptability*? What ability would the value chain gain?

- What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?

- What can be done to *manage* the resource flows? What ability would the value chain gain?
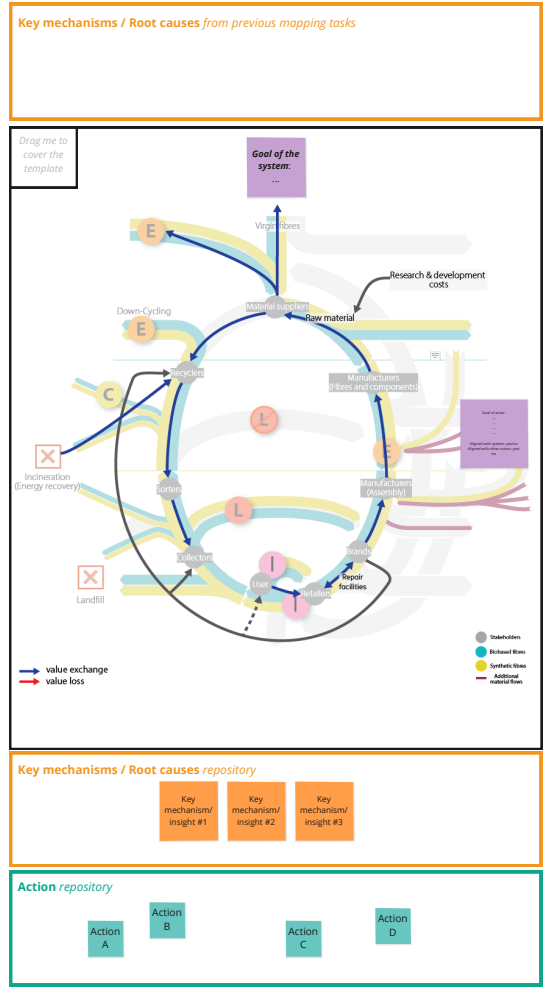
- What else?

3. COPY ALL KEY MECHANISMS TO THE ACCORDING REPOSITORY IN THE NEXT MAPPING TASK.
4. COPY ALL ACTIONS FROM THE ACTION REPOSITORY TO THE COLLECT AND CLUSTER STEP.

ONTO-DESIDE

#..

This image shows a first draft of the **INFORMATION FLOWS** (as prepared in the process of D6.1). That is, it provides a first draft of the data required, where information may act as an enabler or barrier.

Key mechanisms / Root causes *from previous mapping tasks*

Drag me to cover the template

Secure secondary material sourcing hindered by lack of data on materials

Origin of product
Material suppliers
Description of material and sustainability claims by suppliers

Recyclers
Matching products to appropriate recyclers based on material knowledge & recycling methods
Manufacturers (Fibres and components)
Material composition: What materials and substances are added to the product

Information on material quality & disassembly guidance
Process traceability: Ensuring that product is made of claimed materials

Sorters
Lack of repair & disassembly guidance: Description needed on how to take components apart at sorting & recycling stage
Manufacturers (Assembly)
Material composition: What materials and substances are added to the product

Material Inventory: What is the shoe made of?
Collectors
Process traceability of components and materials for the shoe's assembly

Description for the user on how to disassemble the shoe
Users
Brands
Mechanisms boosting visibility of sustainability & circularity efforts
General product information (size, matter, etc.) & sustainability claims
Retailers

Missing Data   Enablers   Barriers

Stakeholders
Released flows
Synthetic flows
Additional material flows

Key mechanisms / Root causes *repository*

| Key mechanism/ insight #1 | Key mechanism/ insight #2 | Key mechanism/ insight #3 |

Action *repository*

Action A   Action B   Action C   Action D

Put me where the barrier is >   🚫

Put me where the enabler is >   👍

Put me where 'it depends' is >   ⚠️

Put me where 'other' is: (other)

Add post-its to explain why: 🚫 Why?   👍 Why?   ⚠️ Why?

Add post-its for each action   In what way?

INFORMATION, DATA, MEMORY & COMPUTATION

Why: *Information management involves collecting, analysing, and distributing data to ensure all relevant actors have the necessary information. Information management includes effectively handling communication, timely updates, and feedback loops to support decision-making and maintain the system. This includes the ability to store data (memory) as well as compute for different purposes, meaning that one needs the ability to handle and process data - sometimes in large quantities.*

You represent: *The resource, energy and value flows and you want to know what information, data, memory and computation is necessary to enable a smooth and efficient flow.*

1. MAP & ANALYSE - *Create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave*

- You have already identified key mechanisms and root causes during the previous mapping activities, which should be located in the **upper orange key mechanisms repository**.
  - Now, **reflect on the information flow elements associated with these root causes**. Are there any additional factors that contribute to these root causes from a value perspective?
  - **Write any additional key mechanisms on the orange post it notes.**
- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - Does sufficient knowledge exist to facilitate the proposed solution?
  - Where is speciality knowledge / particular knowledge required?
    - Is external knowledge required? Are external (experts) available to support the system?
  - Is the necessary information readily accessible?
    - What forms does the data have?
  - If the information is available, is it being effectively shared with relevant actors (who requires it)?
    - How is information sharing / communication handled?
  - What are the incentives for actors to share information?

2. GENERATE ACTIONS - *How to influence the behaviour of the value chain by addressing the key mechanisms...*
- **To acquire the ability to take action** and be able to make your value chain more circular, it is important to address the key mechanisms/root causes.
- **Utilise the key mechanisms to identify the necessary actions to be taken.**
  - That is: Carefully consider the key mechanisms that you have identified through the previous steps. What actions need to be taken to address/overcome/prevent these key mechanisms?
- Write these actions on the **teal post-its** and place them in the action repository.

You may think of things like:
- What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?

- What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?

- What can be done to enhance *adaptability*? What ability would the value chain gain?

- What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?

- What can be done to *manage* the resource flows? What ability would the value chain gain?

- What else?

3. COPY ALL KEY MECHANISMS TO THE ACCORDING *REPOSITORY IN THE NEXT MAPPING TASK.*
4. COPY ALL ACTIONS FROM THE ACTION REPOSITORY TO THE *COLLECT AND CLUSTER* STEP.

#..

This image shows all the resource, energy and value flows of the circular value network (as prepared in the process of D6.2). It provides a space to interrogate the INFRASTRUCTURE AND ENABLING ASSETS for the construction use case.

Key mechanisms / Root causes *from previous mapping tasks*

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is: (other)

Add post-its to explain why: Why? Why? Why?

Add post-its for each action   In what way?

Key mechanisms / Root causes *repository*

| Key mechanism/ insight #1 | Key mechanism/ insight #2 | Key mechanism/ insight #3 |

Action *repository*

Action A Action B Action C Action D

INFRASTRUCTURE & ENABLING ASSETS:

Why: *Infrastructure and enabling assets refer to those things that are not part of the flows themselves, but that are needed to make flows flow. These are the assets that are needed or make it easier to connect flows from one point to another and that enable the value chain to create and capture value.*

You represent: *The resource, energy and value flows and you want to flow as smoothly and efficiently as possible .*

1. MAP & ANALYSE - *Create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave*

- You have already identified key mechanisms and root causes during the previous mapping activities, which should be located in the **upper orange key mechanisms repository**.
  - Now, **reflect on the infrastructure elements associated with these root causes**. Are there any additional factors that contribute to these root causes from a value perspective?
  - **Write any additional key mechanisms on the orange post it notes.**

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - Is the infrastructure readily available?
  - Is the required capacity available?
  - Do the circular solutions require additional infrastructure/enabling assets for its implementation? (e.g., does the customer need additional support?)

2. GENERATE ACTIONS - *How to influence the behaviour of the value chain by addressing the key mechanisms…*
  - **To acquire the ability to take action** and be able to make your value chain more circular, it is important to address the key mechanisms/root causes.
  - **Utilise the key mechanisms to identify the necessary actions to be taken.**
    - That is: Carefully consider the key mechanisms that you have identified through the previous steps. What actions need to be taken to address/overcome/prevent these key mechanisms?
  - Write these actions on the **teal post-its** and place them in the action repository.

You may think of things like:
  - What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?

  - What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?

  - What can be done to enhance *adaptability*? What ability would the value chain gain?

  - What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?

  - What can be done to *manage* the resource flows? What ability would the value chain gain?
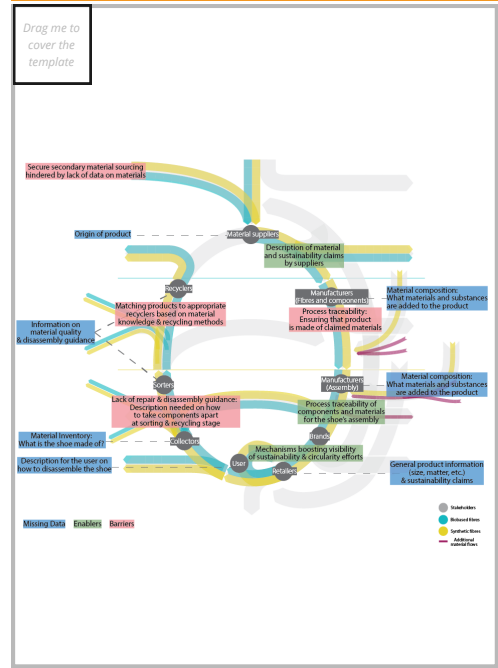
  - What else?

3. COPY ALL KEY MECHANISMS TO THE ACCORDING *REPOSITORY IN THE NEXT MAPPING TASK.*
4. COPY ALL ACTIONS FROM THE ACTION REPOSITORY TO THE *COLLECT AND CLUSTER* STEP.

#..

This image shows all the resource, energy and value flows of the circular value network (as prepared in the process of D6.2). It provides a space to interrogate the circular systems interrelations with the SYSTEM ENVIRONMENT for the construction use case.

Key mechanisms / Root causes *from previous mapping tasks*

Drag me to cover the template

TRENDS / DEVELOPMENTS

[Trends & Developments]   [Trends & Developments]

[NAME THIS SUPER-SYSTEM]

[NAME THIS SUPER-SYSTEM]

[NAME THIS SUPER-SYSTEM]

Unit of analysis: …

Put me where the barrier is >

Put me where the enabler is >

Put me where 'it depends' is >

Put me where 'other' is: (other)

Add post-its to explain why: Why?   Why?   Why?

Add post-its for each action   In what way?

Key mechanisms / Root causes *repository*

| Key mechanism/ insight #1 | Key mechanism/ insight #2 | Key mechanism/ insight #3 |

Action *repository*

Action A   Action B   Action C   Action D

SYSTEM ENVIRONMENT

Why: *Your value chain is embedded in a larger environment: a sector, with cross-sectoral linkages and a larger legislative and cultural environment. What trends and developments could (further) support the goal of the system? What changes would undermine it and favour other possibilities?*

You represent: *The four flows and you want to be integrated within the bigger context as well as possible to ensure smooth operation of your system.*

1. MAP & ANALYSE - *Create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave*

- **Define the boundaries:** of the system. What defines a useful boundary for your system? Write down the unit of analysis on the grey post it.
- **Define the super-system(s) that your system is embedded in.**
  - That is: What (or who) is on the other side of the boundary or your system?
  - Label the super-systems that the system is embedded in by **writing the names on the pink placeholders.** (Examples may include: industries, and national governments & their regulations)
- You have already identified key mechanisms and root causes during the previous mapping activities, which should be located in the **upper orange key mechanisms repository**.
  - Now, **reflect on the system environment elements associated with these root causes**. Are there any additional factors that contribute to these root causes from a value perspective?
  - **Write any additional key mechanisms on the orange post it notes.**

- For the above, think of things like (choose the considerations that are most relevant for your value chain):
  - What are the local and global conditions for the proposed solution? (e.g., demand, legislation)
  - Which rules or standards are in place that necessitate conformance?
    - How does this impact your value chain?
  - How do current macro developments and trends (e.g., legislative, market) influence the system environment?
    - What are anticipated developments that could impact the proposed solution and (societal) macro goals?

2. GENERATE ACTIONS - *How to influence the behaviour of the value chain by addressing the key mechanisms…*

- **To acquire the ability to take action** and be able to make your value chain more circular, it is important to address the key mechanisms/root causes.
- **Utilise the key mechanisms to identify the necessary actions to be taken.**
  - That is: Carefully consider the key mechanisms that you have identified through the previous steps. What actions need to be taken to address/overcome/prevent these key mechanisms?
- Write these actions on the **teal post-its** and place them in the action repository.

You may think of things like:
- What can be done to better *understand* the resource flows and their relations? What ability would the value chain gain?
- What can be done to better *evaluate* resource flow actions and processes? What ability would the value chain gain?
- What can be done to enhance *adaptability*? What ability would the value chain gain?
- What can be done to enhance *collaboration* (among actors)? What ability would the value chain gain?
- What can be done to *manage* the resource flows? What ability would the value chain gain?
- What else?

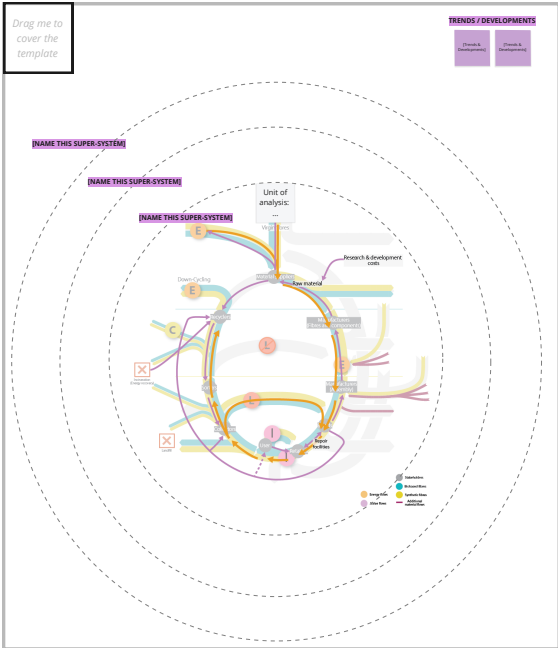**3. COPY ALL KEY MECHANISMS TO THE ACCORDING** *REPOSITORY IN THE NEXT MAPPING TASK.*
4. COPY ALL ACTIONS FROM THE ACTION REPOSITORY TO THE *COLLECT AND CLUSTER* STEP.

STEP (1) COLLECT & CLUSTER

- **Gather all actions from the Action repositories here** by copying them from each mapping task to the respective action repositories below (boxes with dashed lines). Placing them in the according box will help you to remember the context and details of the actions.

- Next, copy the actions from all action repositories into the *collect and cluster space* and **group them according to whether they are related to each other.** The goal is to understand where actions defined in the mapping tasks overlap, and to combine and condense them.

- **Name the new groups with a new title.** If helpful for you, you may consider indicating the connections of the action clusters through connective lines/arrows (think of a mind map).

Collect & Cluster

Action A
Action B
New title
Action B
Action C

Action A
New title
Action C
Action D
Action A

Action B

New title
Action D
Action B
Action C
Action D

Action D

Action C

Resource flow *actions*

Value flow *actions*

Energy flow *actions*

Information flows, data, memory & computing *actions*

Infrastructure & enabling assets *actions*

System environment *actions*
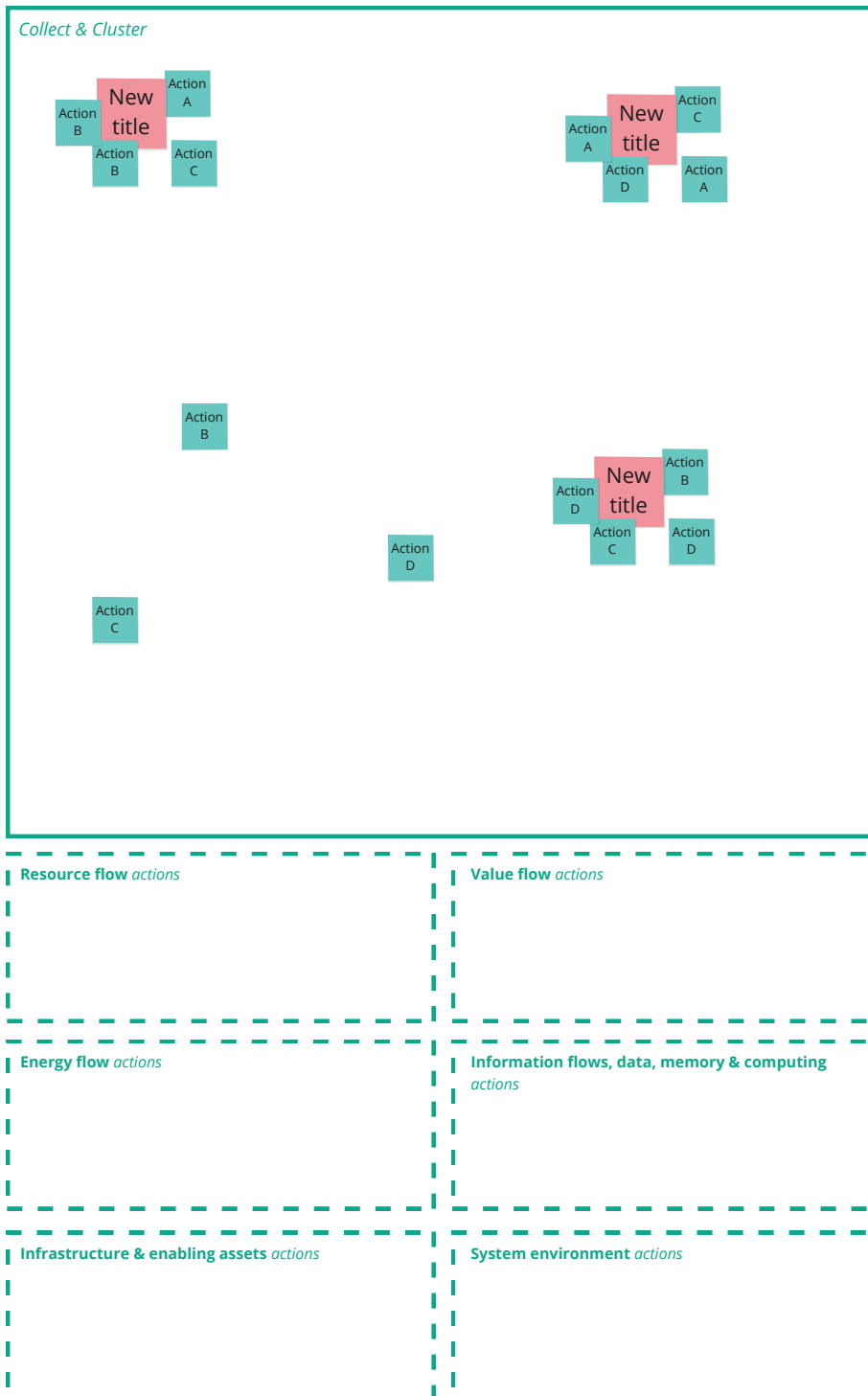
STEP (2) REFINEMENT

- Copy the newly named actions over to the *summary repository*.
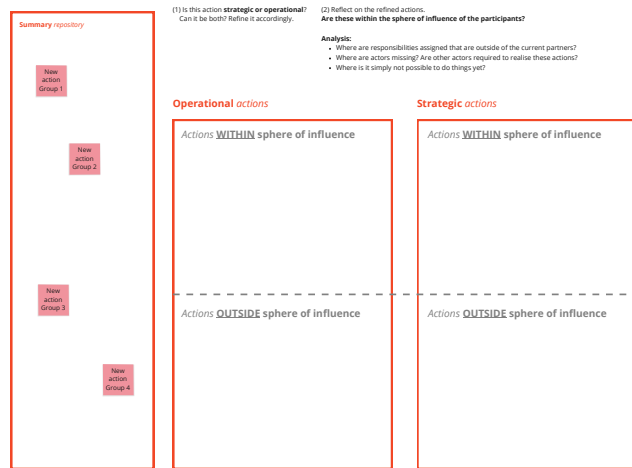
Refinement 1:
- **Categorise the actions** according to **whether they are *strategic* actions or *operational*** ones.
  - *While categorising the actions, it may become clear that there are two sides to an action - an operational and a strategic side. In that case: place the action in both categories and refine it accordingly.*
  - *For example, it may be required to pass legislation to enforce certain behaviour (a strategic action), yet what consequences would this have operationally, i.e., what actions would need to be taken once that legislation is passed? In that manner, revisit the actions previously defined.*
- In the process of refining the actions, consider whether they are **within the sphere of influence of the participants** or ***outside* of the sphere of influence**, and **categorise the actions** accordingly.

Refinement 2:
- Copy all actions that are ***within your sphere of influence*** to the next step - the prioritisation.
  - *Reflect on the actions that are **outside your sphere of influence. Are there possibilities to bring these actions within your sphere of influence?***

Refinement 1

Summary *repository*

New action Group 1

New action Group 2

New action Group 3

New action Group 4

(1) Is this action **strategic or operational**?
Can it be both? Refine it accordingly.

(2) Reflect on the refined actions.
Are these within the sphere of influence of the participants?

Analysis:
- Where are responsibilities assigned that are outside of the current partners?
- Where are actors missing? Are other actors required to realise these actions?
- Where is it simply not possible to do things yet?

Operational *actions*

Actions __WITHIN__ **sphere of influence**

Actions __OUTSIDE__ **sphere of influence**

Strategic *actions*

Actions __WITHIN__ **sphere of influence**

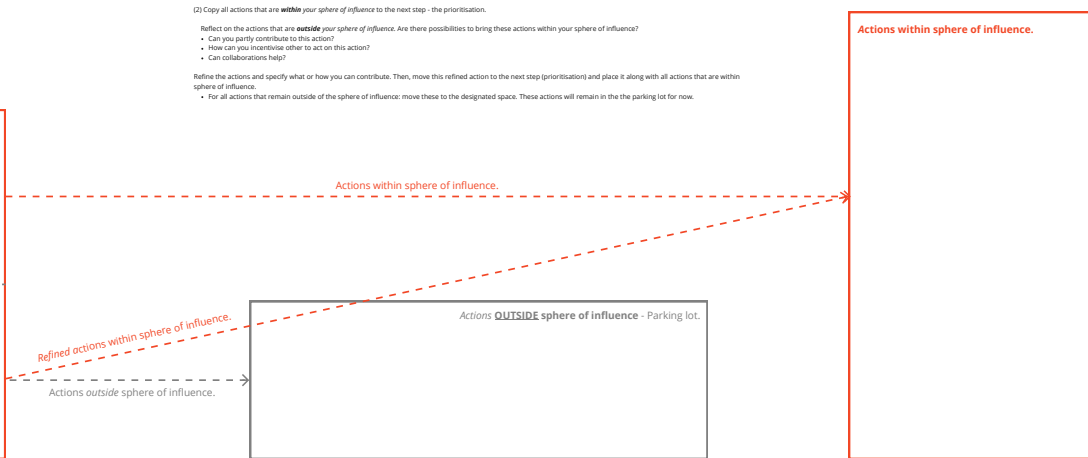*Actions* __OUTSIDE__ **sphere of influence**

Refinement 2

(2) Copy all actions that are ***within your sphere of influence*** to the next step - the prioritisation.

Reflect on the actions that are ***outside*** your sphere of influence. Are there possibilities to bring these actions within your sphere of influence?
- Can you partly contribute to this action?
- How can you incentivise other to act on this action?
- Can collaborations help?

Refine the actions and specify what or how you can contribute. Then, move this refined action to the next step (prioritisation) and place it along with all actions that are within sphere of influence.
- For all actions that remain outside of the sphere of influence: move these to the designated space. These actions will remain in the the parking lot for now.

Actions within sphere of influence.

Refined actions within sphere of influence.

Actions *outside* sphere of influence.

Actions __OUTSIDE__ **sphere of influence** - Parking lot.

Actions within sphere of influence.

STEP (3) PRIORITISE & ASSIGN

- **Prioritise the actions** that are within your sphere of influence. According to what criteria would you prioritise the actions? Please specify these criteria.
  - Optionally – Two common criteria that you may use if applicable to your case are: *the impact that the action can have* and *the resources required to implement the action.*

- **Assign responsible actors where you can.** Use the grey post its to write down which actors will be responsible for the action.
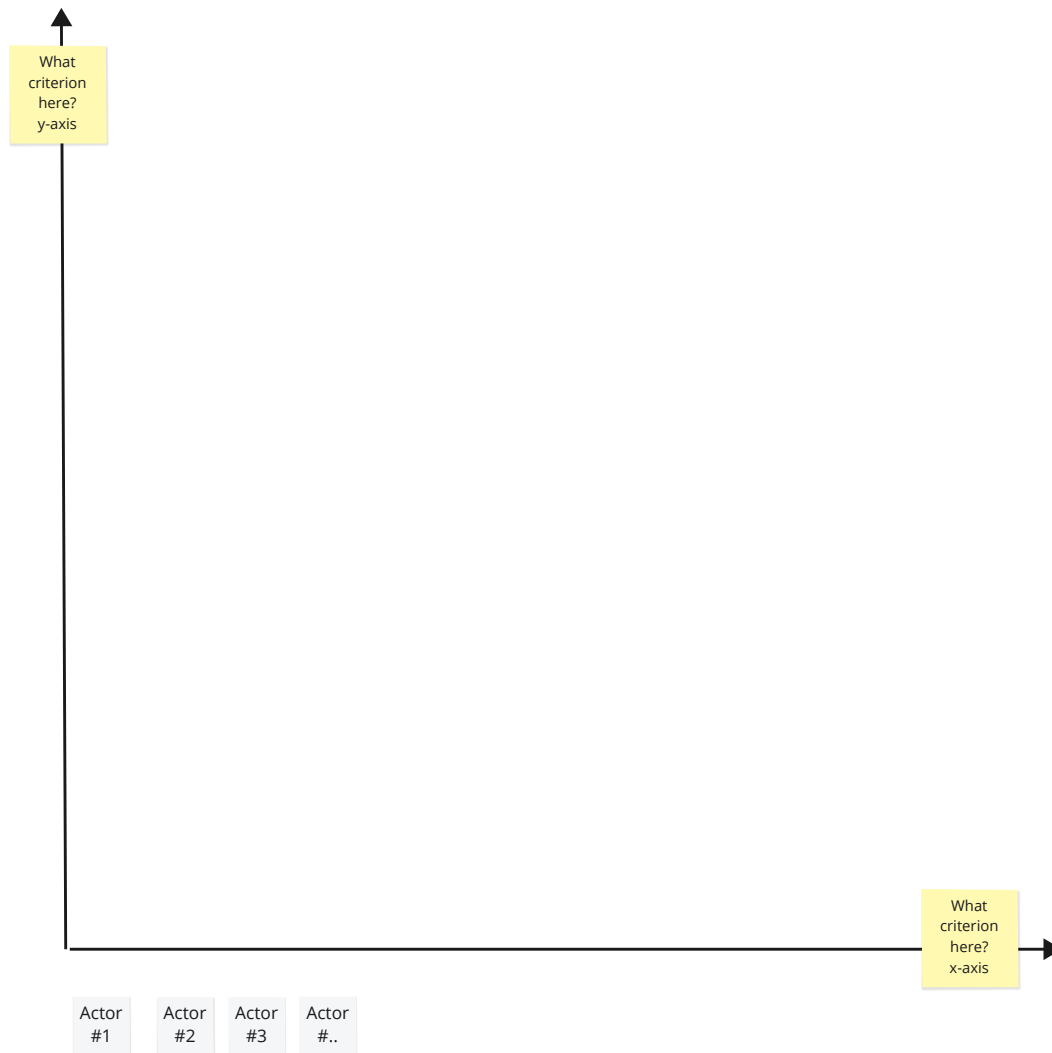
What criterion here? y-axis

What criterion here? x-axis

Actor #1

Actor #2

Actor #3

Actor #..

STEP (4) TIME PLANNING: *NOW, NEAR, FAR*

- **Fill out the name of the actors involved** (yellow post its).
- Then **allocate the activities to the appropriate actor** and **place** them **on the timeline**.
- Keep the prioritisation from Step 3 in mind:
  - What actions did you assign a high priority?
  - Which ones should you start with?

Actor #1

Actor #2

Actor #3

Actor #4

NOW   NEAR   FAR
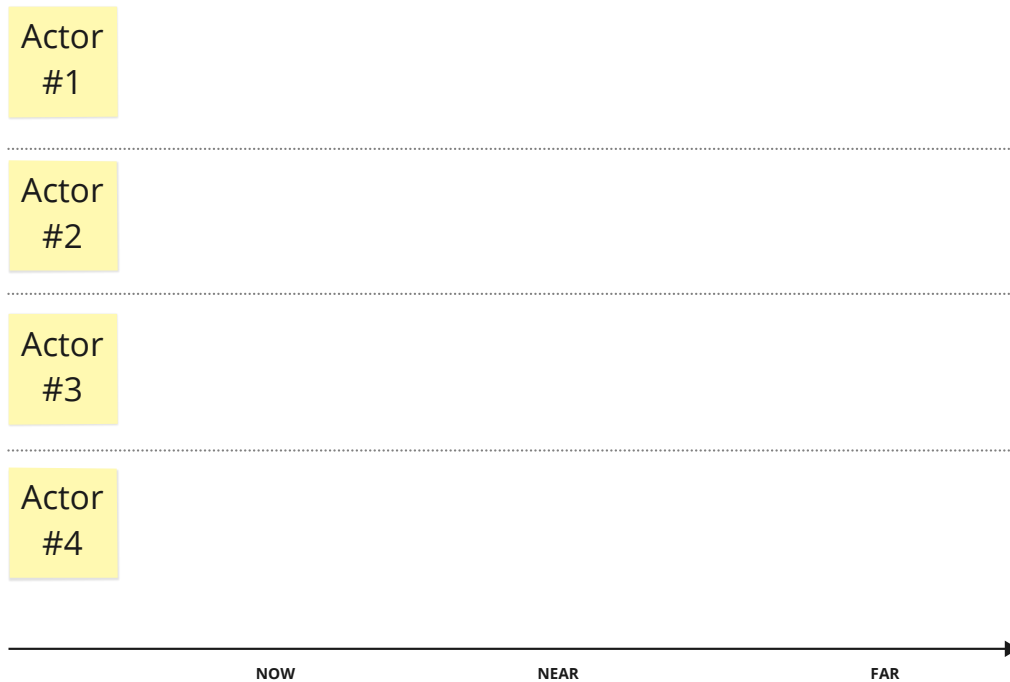
Appendix 7 Multi-Flow Method Workbook

This Appendix presents a first draft of the facilitation workbook for the Multi-Flow Method. The workbook will be further developed within WP7. All layout and design will be adapted within WP7.

MULTI FLOW METHOD WORKBOOK – Table of Contents

Introduction to Circular Economy

Today society faces many severe environmental challenges, such as biodiversity loss, resource depletion and climate change. Many of these consequences can be traced back to the predominant linear economic system as the current 'take, make, use, dispose" paradigm has led to the consumption of resources beyond the regenerative capacity of our ecosystems[1,2]. It becomes apparent in society's excessive resource usage: at the moment, humanity uses the equivalent of 1.7 earths[3]. The number increases to 2.8 earths if everybody would live like an average EU resident. A radical shift in current production and consumption patterns and the organisation thereof is required[4]. Circular Economy (CE) is regarded as a promising alternative approach which simultaneously respects planetary boundaries and ensures economic and societal well-being[5,6]. However, despite its potential, the implementation of a CE is still at a nascent stage.

In essence, Circular Economy is an umbrella concept that groups a wide variety of strategies, all for the purpose of value retention, reduction of value loss or alternative ways of value creation[1,7,8]. In its early stages, CE focused on waste and resource management strategies that aimed at extending product and material life through strategies such as recycling and remanufacturing[8]. While such circular strategies are, amongst others, still an integral part of the implementation of a CE, the understanding of a circular economy nowadays is more holistic, and challenges established assumptions. That is, CE encompasses a wide range of strategies that promote product, component and material conservation, efficiency, and productivity, e.g., recycling, reuse, maintenance, and manufacturing. Moreover, CE also involves strategies that look more directly at how value can be created or value loss reduced from a system point-of-view, e.g., for all stakeholders[7]. The concept of CE thus requires a rethinking of not only how resources flow through systems, but also who benefits and in what way, in order to realise the urgently required shift from the current linear economic model to a circular economic system[4,9]. This implies that more holistic and collaborative approaches are required[4,9].

The Multi-Flow Method developed within the Onto DESIDE project supports the implementation of holistic circular value networks by helping practitioners understand the connection of resource-, value-, energy-, and information flows, and ongoing interactions and interdependencies. It helps users to identify improvement opportunities for their circular value chains and develop actions to address these.

Introduction to Onto-DESIDE

The implementation of a Circular Economy is not only hindered by the lack of consideration of complex systems; further, a lack of support for also 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. Onto-DESIDE addressed the core challenges of making decentralised data and information understandable and usable for humans as well as machines. The project leveraged open standards for semantic data interoperability in establishing a shared vocabulary (ontology network) for data documentation, and a decentralised digital platform that enables collaboration in a secure and privacy-preserving manner.

The project addressed a number of 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, analyse and assess new circular value chain configurations opened up 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, acted 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 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.

The results of Onto-DESIDE are:

- The Multi-Flow Method (the current workbook)
- The Circular Value Network Ontology (workbook #)
- The Open Circularity Platform (workbook #).

The roadmap below provides an overview of how the three workbooks are connected and indicates when to use each one.

Placeholder for training material roadmap – to be developed within WP7.
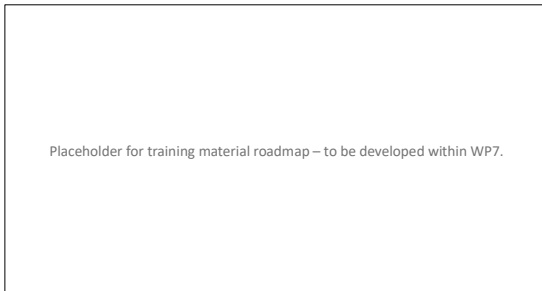
The Multi-Flow Method

What's in it for the Stakeholders?

The Goal

Circular value systems differ from linear systems in that all components must work together for the system to function effectively and remain robust. Circular value chains are unique in the sense that feedback loops exist: their output is also their input. Weak links within the system pose a threat to the entire circular system and each actor involved in creating and capturing circular value. Because of that, it is important to take a systems perspective to understand the dynamics of the whole value chain. **The Multi-Flow Method will help you to apply a systems perspective and better understand how the circular value chain can function better as a whole.**

That is: instead of focusing on a small set of local phenomena, the method helps you to examine the relationships between different points of interaction and how the sum of this creates the behaviour of the value chain. The Multi-Flow Method guides you in the exploration of: What works well and what problems have been already solved? What does not function well and where do problems remain? What should the value chain look like and function instead – and what actions can be taken to get there? **The goal is to identify improvement opportunities for your circular value chain and to strengthen its innovation capacity.**

Expected Outcomes

The Multi-Flow Method will help you to identify improvement opportunities for your circular value chain. You will develop action points for the design and implementation of circular economic practices. The actions include **necessary steps to be taken for the value chain to function as a whole.** Actions that are within your sphere of influence are prioritised, assigned to relevant actors and organised according to the implementation timing.

When and how to use it

Use the method when you need a comprehensive understanding of how different elements within your circular value chain interact and impact one another. This method is particularly useful when working with diverse stakeholders who have varying roles and perspectives. You can use the Multi-Flow Method in workshops, strategic planning sessions, or any setting where cross-functional collaboration is required to identify and resolve issues within the circular value chain. Key participants should (ideally) include representatives from all relevant parts of the value chain—such as suppliers, manufacturers, distributors, and customers—to ensure that insights are comprehensive and actions are effective.

You have two options to work with the Multi-Flow Method: via the online whiteboard tool Miro or via the PDF templates.

- **Use the online Miro version** when participants are geographically dispersed or when a more interactive and dynamic session is required. Miro's collaborative features allow for real-time interaction, which is ideal for capturing immediate feedback, co-creating solutions, and ensuring that all voices are heard.
- **Opt for the PDF templates** in scenarios where technology might be a barrier—such as when participants have limited access to stable internet connections or are not comfortable using digital tools. The offline version is also suitable for in-person workshops where face-to-face interactions and hands-on activities can enhance collaboration.

Choosing the right version depends on your specific context, the participants involved, and the resources available. Both versions are designed to provide flexibility and effectiveness, ensuring the Multi-Flow Method can be adapted to suit your needs.

What to expect

The Multi-Flow Method consists of two parts: 1) the flow analysis and 2) the action organisation. Part 1) includes six individual boards, called *mapping tasks*, for:

- Resource flows
- Value flows
- Energy flows
- Infrastructure and enabling assets
- Information flows, data, memory & computation
- System environment.

The purpose of these mapping tasks is to create a shared understanding of barriers and enablers for the respective flows of your value chain and to generate relevant actions to address shortcomings. Whilst a barrier or enabler may feature in multiple mapping tasks, these different tasks serve to highlight different dimensions or aspects of it – and thus help you to gain a deeper insight into the respective topic.

The result of each mapping task is the identification of actionable items that are then used in the second part of the method, the action organisation. The purpose of the second step is to condense and organise the actions in a way that helps you to take initiative and ownership, but also see where you can collaborate (e.g. have shared responsibilities and mutual interests).

(1) Flow analyis   (2) Action organisation
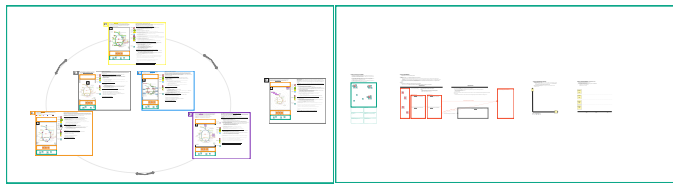
Overview of the Multi-Flow Method

The Steps

Preparing your workspace

Working online – If you choose to work in Miro, open the workspace via the following link: [placeholder: link will be provided in D5.3]. As an initial step, familiarise yourself with the workspace, i.e., zoom in and out on the board to locate all elements within the workspace and take a first look at the method to understand its contents.

Working offline – If you choose to work offline, print the templates in a size that is sufficient for the number of people you will work with. It is recommended to print the mapping space of each mapping task (Part 1) as well as all steps of the action organisation (Part 2) in A0. The instructions section of each mapping task (Part 1) may be printed in smaller format. Organise post its (or coloured paper and tape) in green, red, orange, teal/blue and grey. If you decide to work with other colours, make sure that they are consistently used throughout the process.

Before starting

[to be completed in D5.3 – This subchapter will be written once the Multi-Flow Method has been further developed and it has been decided how to integrate the method with other Circularity Thinking tools. This subchapter will discuss how participants will create the pre-mapping required for the mapping tasks.]

The Process

Each step of the Multi-Flow Method is described in the respective following chapters. The general process of the method is the following:

1 – Start With the Resource Flows Mapping Task
This task builds the starting point of the method. Mapping and analysing the resource flows helps you to develop a foundation for all other mapping tasks, making it the most time intensive one. You are developing a first set of key mechanisms and root causes that stand in the way of making the value chain more circular. Carry over these key mechanisms to the next mapping task.

2 – Continue With Other Mapping Tasks
After completing the Resource Flow task, choose another mapping task. While you may approach the completion of the mapping tasks in order, it is likely that the mapping tasks will be an iterative process. That is: you will most likely switch back and forth at times between the mapping tasks as a conversation during one mapping task may trigger a thought for another one.

3 – Completing Sufficient Number of Tasks
Even though all flows as well as the system environment and infrastructure tasks are important for gaining a detailed understanding of the circular value network as a whole, the completion of four mapping tasks may already be considered sufficient to fulfil the requirements of the first part of the method. Select the mapping tasks that are the most relevant to your value chain.

4 – Organising the Actions
After you have finalised the mapping tasks, copy over *all* actions from the respective action repositories to the *collect and cluster* task. This starts the second part of the Multi-Flow Method. Follow the instructions given in each step of Part 2, i.e., the *collect and cluster* step, the *refinement* step, *prioritise and assign* step, and the allocation to the *now, near, and far* future to complete Part 2.

Multi-Flow Method Part 1: *The Mapping Tasks*

Each mapping tasks consist of the following parts:
1. a short introduction/overview of what the mapping tasks pertains to (top of the template),
2. the instructions and guiding questions (on the right)
3. a mapping area combined with the repositories for *key mechanisms* and *actions* (on the left side),
4. a space for you to indicate in which order you have completed the mapping task (rectangle top left corner).

The Value Mapping Task below serves as an example of all mapping tasks.

The *Value Flows Mapping Task* as an example of a mapping task

The first step is to *map & analyse* – to "create a shared picture of what's important for circular value flows and how the circular value flow is expected to behave". For all mapping tasks (aside from resource flows), this step includes a reflection on the key mechanisms defined in the previous mapping tasks. These were noted on orange post its and placed in the *Key Mechanisms Repository* prior to starting the mapping task. Reflect on the mapping task-specific elements of the root causes. For example: What are the value elements associated with the root causes? Are there any additional factors that contribute to these root causes from a value perspective? Each mapping task further includes topic specific prompts to guide you.

Write down any barriers to the circular value chain on red post its and enablers on green ones. The different coloured post its help you to transfer the discussions onto the mapping space so that the discussions can be documented, and a shared picture and understanding emerges. If you are working online, use the icons included for each mapping task to further detail your notes, e.g., the green thumb for enablers. Write down any additional key mechanisms you identified through the topic specific prompts and the analysis of the barriers and enablers on orange post its and place them in the lower orange action repository.

The second step of the mapping task is to *generate actions* – "to influence the behaviour of the value chain by addressing the key mechanisms". That is: utilise the key mechanisms to identify the necessary actions to be taken, and to identify what actions need to be taken to address/overcome/prevent these key mechanisms. Note the actions on teal post its and place them in the teal action repository.

To conclude the mapping task and prepare subsequent steps, copy all key mechanisms to the according repository in the next mapping task" and copy all actions from the action repository to the collect & cluster step.

Resource Flows

What?
Materials, components and finished products
Why?
For circular flows to be realised and function well it is important that the exchanges - when a resource changes hands from one actor to another - function smoothly enabling the system's OUTPUTS to also become its INPUTS.
What is needed?
[Placeholder – to be further specified in Method development process]
People
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]
Time
Estimate: 60 minutes
Outcome
• Set of key mechanisms • Actions addressing the key mechanisms

All mapping tasks follow the same general structure except for the Resource flows mapping task. This task builds the starting point for the method and includes one additional step to support a thorough analysis and thus help you to develop a good foundation.

Start the resource flows analysis by discussing the five questions that test your value chain regarding requirements for designing circular value chains. Create a shared picture of the key barriers and enablers for circular resource flows, i.e., identify key barriers for the respective flow (i.e., what obstacles have you encountered) and what enablers are already in place (i.e., what problems have you already solved or what works well at the moment).

Proceed with the steps as they are for all other mapping tasks. That is: 1) to *analyse* and *summarise* the insights on barriers of circular value chains into 2 - 3 key mechanisms/root causes that stand in the way of making the value chain more circular, 2) to *generate actions* for how to influence the behaviour of the value chain by addressing the key mechanisms. The third step is then to *copy all key mechanisms* to the according repository in the next mapping task, while step five is to *copy all actions* from the action repository to the collect & cluster step.

Value Flows

What?
Value, benefits & incentives vs costs & investment and the ability to influence this
Why?
For circular flows to be realised and function well it is important that all actors not only act in line with circular principles, but that there is something 'in it' for them - something that outweighs the costs and investments. And, importantly, that the interests of the different actors align WITH EACH OTHER as well as with the circular system AS A WHOLE.
What is needed?
[Placeholder – to be further specified in Method development process]
People
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]
Time
Estimate: 30 minutes
Outcome
• Additional key mechanisms – if applicable • Actions addressing the key mechanisms related to Value Flows

Energy Flows

What?	
Energy Flows: Materials, components and finished products	
Why?	
Energy inputs and outputs across the system are essential for moving resources, processing materials, and maintaining operations within the system. Integrating energy flows into the planning is important to ensure that resources can be utilised, processed, and circulated in a sustainable manner. This integration enables a seamless resource transition within the system, where energy inputs drive processes that convert outputs back into inputs, and thus enable circularity.	
What is needed?	
[Placeholder – to be further specified in Method development process]	
People	
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]	
Time	
Estimate: 30 minutes	
Outcome	
• Additional key mechanisms – if applicable • Actions addressing the key mechanisms related to Energy Flows	

Information, Data, Memory & Computation

What?	
Information, data, memory & computation	
Why?	
Information management involves collecting, analysing, and distributing data to ensure all relevant actors have the necessary information. Information management includes effectively handling communication, timely updates, and feedback loops to support decision-making and maintain the system. This includes the ability to store data (memory) as well as compute for different purposes, meaning that one needs the ability to handle and process data - sometimes in large quantities.	
What is needed?	
[Placeholder – to be further specified in Method development process]	
People	
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]	
Time	
Estimate: 30 minutes	
Outcome	
• Additional key mechanisms – if applicable • Actions addressing the key mechanisms related to Information Flows	

Infrastructure and Enabling Assets

What?	
Infrastructure & enabling assets	
Why?	
Infrastructure and enabling assets refer to those things that are not part of the flows themselves, but that are needed to make flows flow. These are the assets that are needed or make it easier to connect flows from one point to another and that enable the value chain to create and capture value.	
What is needed?	
[Placeholder – to be further specified in Method development process]	
People	
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]	
Time	
Estimate: 30 minutes	
Outcome	
• Additional key mechanisms – if applicable • Actions addressing the key mechanisms related to Infrastructure and enabling assets	

System Environment

What?	
System Environment	
Why?	
Your value chain is embedded in a larger environment: a sector, with cross-sectoral linkages and a larger legislative and cultural environment. What trends and developments could (further) support the goal of the system? What changes would undermine it and favour other possibilities?	
What is needed?	
[Placeholder – to be further specified in Method development process]	
People	
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]	
Time	
Estimate: 30 minutes	
Outcome	
• Additional key mechanisms – if applicable • Actions addressing the key mechanisms related to Infrastructure and enabling assets	

The System Environment Mapping Task includes three circles increasingly further removed from the value chain mapping to represent super-systems. Examples of super-systems may include industries, and national governments & their regulations. To have a focused conversations about the system environment, complete the following steps prior to the evaluation and further development of key mechanisms:

- Define the boundaries: of the system. What defines a useful boundary for your system? Write down the unit of analysis on the grey post it.
- Define the super-system(s) that your system is embedded in.
  - That is: What (or who) is on the other side of the boundary or your system?
- Label the super-systems that the system is embedded in by writing the names on the pink placeholders.
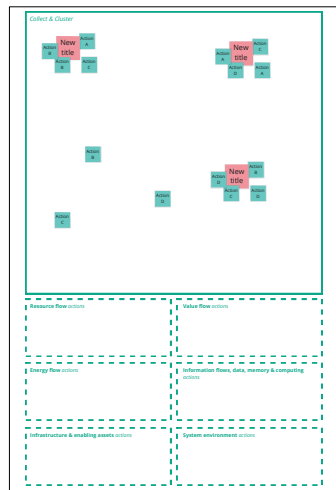
Multi Flow Method Part 2: *Action Organisation*

Part 2 of the Multi-Flow Method consists of four steps: collect & cluster, refinement, prioritise & assign, and time planning. The goal of the action organisation is to refine the actions and make them more targeted and realisable.

Step 1: Collect & Cluster

What?	
Collecting all actions from the action repositories of the mapping tasks and clustering them to condense the created actions and define key actions.	
Why?	
Given the iterative process and the interconnectedness of the different mapping tasks, some actions may occur in multiple action repositories. The first step is thus to remove any duplicates. But also: to further specify and develop actions that are not yet distinct or clear enough. The second step is to group the actions according to whether they are related to each other. Then, rename the action group with a new title that captures the commonality of the topic.	
What is needed?	
[Placeholder – to be further specified in Method development process]	
People	
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]	
Time	
Estimate: 45 minutes	
Outcome	
• Removal of duplicates • Key action groups	

Part 2 – Step 1: Collect & Cluster

Step 2: Refinement

What?	
Refinement of all actions to advance actions in a more specific and actionable way, consisting of two subtasks.	
Why?	
The refinement helps to reflect more critically on the actions and identify different aspects for them. The differentiation between those within the sphere of influence supports the process of making the actions more realisable.	
What is needed?	
[Placeholder – to be further specified in Method development process]	
People	
[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]	
Time	
Estimate: 30 minutes	
Outcome	
• Development of more targeted actions • Differentiation between those within sphere of influence and those outside	

Refinement 1

First, differentiate between *strategic* and *operational* actions: 1) actions that are long-term and aimed at achieving broader goals (strategic) versus short-term and focused on immediate tasks (operational). The differentiation helps to reflect more critically on the actions and identify different aspects for them. For example, a strategic action may be that regulation is required to overcome a barrier; yet the operational implication of this action should also be considered – if the regulation would be implemented, what would this mean operationally for partners? The goal of this step is thus to further specify the actions, adding additional ones where necessary. In the process of refining the actions, consider whether the actions are *within* your sphere of influence or *outside* of your sphere of influence. Categorise them accordingly.
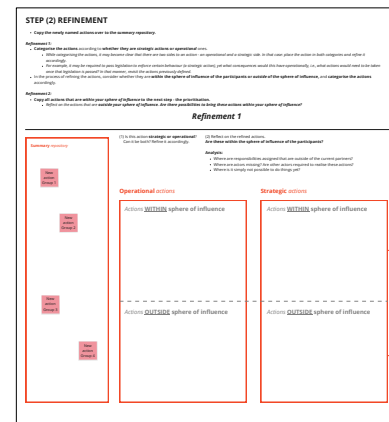

Part 2– Step 2: Refinement 1

Refinement 2

Consider *if* and *how* actions *outside* of your sphere of influence can be brought *into* the sphere of influence. Therefore, first copy all actions that are *within* your sphere of influence to Step 3, the *Prioritisation*.

Then reflect on the actions that are outside your sphere of influence and whether possibilities exist to bring these actions within your sphere of influence. Based on your analysis, refine actions or add additional ones. Move the refined actions to the space dedicated to all actions within your sphere of influence.
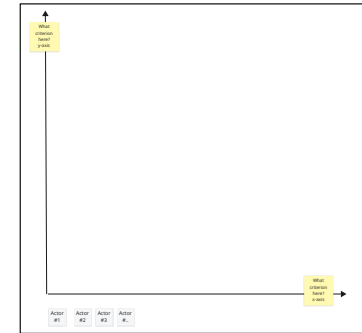
All actions that remain outside your sphere of influence are moved to a parking lot.

Part 2 – Step 2: Refinement 2
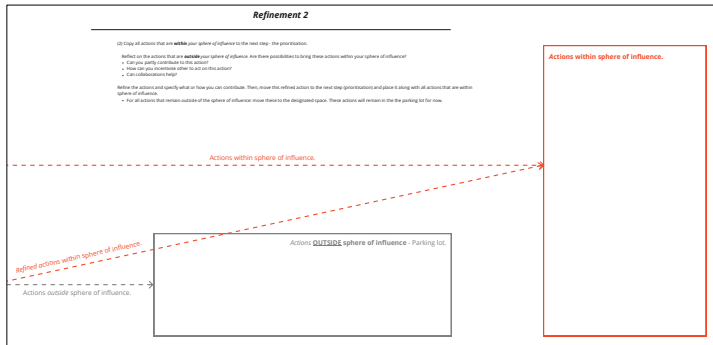
Step 3: Prioritise & Assign

What?	Prioritisation of the actions and assigning them to relevant actors.
Why?	To be able to develop time plan in the next step.
What is needed?	[Placeholder – to be further specified in Method development process]
People	[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]
Time	Estimate: 30 minutes
Outcome	• Prioritisation of actions • First draft of actor responsibility for actions

Prioritise the actions that are within your sphere of influence according to criteria which you consider the most relevant. Two criteria that are commonly used by participants are the *impact that the action* can have (or the potential that the action holds to bring about change) and the *resources required* to implement the action (including financial-, human-, and physical resources, knowledge required, etc.). You may use these criteria if applicable to your value chain. Where possible, assign actors already to the actions using the grey post its.

Step 4: Time allocation

What?	The allocation of the actions according to timing and actors.
Why?	To develop an implementation plan.
What is needed?	[Placeholder – to be further specified in Method development process]
People	[Placeholder – to be further specified in Method development process what expertise will be required to obtain the best results]
Time	Estimate: 30 minutes
Outcome	• Implementation plan • Clarity on responsibility of actions.

The final step of the action organisation process is the allocation of the actions according to timing and actors. List relevant actors on the yellow post its. Copy over the action groups from the previous steps to this workspace and allocate them 1) to the respective actor, and 2) according to when this action shall be addressed. While you do these steps, keep the action prioritisation from the previous step in mind. For example, the prioritisation can be relevant for the timing considerations, i.e., the level of priority can influence whether an action shall be addressed, now, near or far.

STEP (4) TIME PLANNING: *NOW, NEAR, FAR*

- **Fill out the name of the actors involved** (yellow post its).
- Then **allocate the activities to the appropriate actor** and **place them on the timeline.**
- Keep the prioritisation from Step 3 in mind:
  - What actions did you assign a high priority?
  - Which ones should you start with?

Actor #1

Actor #2

Actor #3

Actor #4

NOW   NEAR   FAR

Part 2 – Step 4: Time allocation

This step concludes the Multi-Flow Method and results in an overview of actions to be taken for each actor, as well as an indication of their common interests and shared responsibilities.

Method Application: An Example

[Placeholder for example – an example will be provided in the next iteration]

Next Steps

[Placeholder – the next steps will be developed in coordination in WP7 (in collaboration with partners from WP3 and WP4)]

References

[References are not included in this guide since all references are already included in the D5.2 references.]

Templates

[Placeholder – The PDF Templates are not included here as they are already included in the Appendix of D5.2]