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# Making sense of circular economy: Understanding the progression from idea to action

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## Abstract

This study examines how management and organisation sciences can contribute to and accelerate circular economy (CE) practices by providing insight into how circular oriented innovation (COI) processes unfold. Emergent theory and recent empirical evidence shows that research into CE needs to acknowledge both salient *commonalities* between circular solutions, but—crucially—also their *differences*. A range of well-known circular strategy frameworks exist that offer suggestions for understanding circular strategies in relation to each other. However, at present such frameworks tend to be normative and conceptual. Our objective is therefore twofold: (1) to develop an analytical framework for CE that is grounded in both theory and practice, as well as (2) to demonstrate the application of such a framework to a wide range of different circular solutions and how this can lead to new insights and new directions for research. We deploy a longitudinal qualitative multi-case case study design, where we focus on business-led COI projects, covering innovation projects of 23 product(s) (groups) for 19 focal companies. We identify circular pivots, minimal viable circular configuration, continuous improvement of circular configurations and interactions between circular strategies as particularly important phenomena and the importance of taking a longer time horizon to understand circular phenomena in business. Moreover, we identify a lack of application of structured approaches in practice—to complexity, to circular strategies and to value network development—which, if left unaddressed, pose a risk that CE will not achieve a positive systemic impact.

## KEYWORDS

circular configurations, circular oriented innovation, circularity Compass, closed-loop, framing, fuzzy solutions, meaning work, multi-flow metabolism, sensemaking, uncertainty

## 1 | INTRODUCTION

The circular economy (CE) concept focuses on how value can be created and value loss reduced or avoided through addressing structural waste. Structural waste<sup>1</sup> includes wastes that are clearly visible and

easily identifiable as well as wastes that are inconspicuous, invisible and more difficult to point to. ‘Waste’ in this context means to negatively impact the conservation, efficiency and productivity of resources. Examples of waste and resource management strategies or ‘circular strategies’ that operationalize this concept range from

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recycling to reuse, from sufficiency to sharing, and from maintenance to remanufacturing. Using each of these strategies individually is commonplace in manufacturing. However, grouping under the umbrella concept (Hirsch & Levin, 1999) of 'CE' means that their common capacity to improve waste and resource management is brought to the fore in a new way (Blomsma & Brennan, 2017; Ellen MacArthur Foundation [EMF], 2013; Homrich et al., 2018). In this sense, (elements of) CE are both old *and* new.

Umbrella concepts create and legitimise discursive space(s) (Hirsch & Levin, 1999), and 'CE' is no exception (Blomsma & Brennan, 2017). Umbrella concepts allow for a topic or concept to be discussed and interrogated by clearly delineating it and highlighting that it is important. The dialogue and debate this enables catalyses reflection on and the recognition of knowledge and implementation gaps (Hirsch & Levin, 1999). Understanding the CE as an umbrella concept necessitates acknowledging the *wide range* of circular strategies that exist, and that the examination of the relationship *between* these strategies is of central importance as well as how their application can lead to the rapid transition from linear to circular industrial systems that is so urgently needed (Bauwens et al., 2022; Corvellec et al., 2020; Kirchherr & Santen, 2019). This is compared to the siloed and isolated study and implementation of individual strategies to date.

Emergent theory and recent empirical evidence shows that research into CE needs to acknowledge both salient *commonalities* between circular solutions, but—crucially—also their *differences*. For example, Zink and Geyer (2017) propose different actions for countering negative effects on overall resource use when increasing the circularity of materials versus that of products. Different perspectives lead different stakeholders to distinguish between different success factors, depending on their location in the value chain and whether they have an interest in the circularity of materials or that of products and components (Franco, 2017; Lapko et al., 2019; Machacek et al., 2017). That is, CE groups many circular strategies under its umbrella, but these cannot be treated as interchangeable.

In this sense, the CE umbrella requires us to concede that many inter-related aspects of waste and resource management are not yet fully understood—many of which management and organisation science can contribute to generating relevant knowledge for. This poses a problem: *How can organisation science engage with CE as a complex phenomenon—as opposed to treating it as a single entity or one-dimensional phenomenon?* That is, for CE, what does good scholarship look like? For example, what best practices from innovation processes related to recycling also hold true in reuse contexts? How can the development of business models aimed at stimulating sufficiency be compared with those involving sharing? And what value chain configurations and stakeholder management practices that optimise maintenance outcomes work equally well for remanufacturing - and which don't? No structural investigation of questions such as these has to date been done. To facilitate this, a rigorous approach for understanding the physical reality is needed that allows knowledge to be appropriately contextualised. That is, how can we characterise or describe circular solutions?

A range of well-known frameworks exist that offer suggestions, such as the Waste Hierarchy (EC, 1993), Cradle-to-Cradle™ (Braungart & McDonough, 2002), Performance Economy (Stahel, 2006), but also the Butterfly diagram and the ReSOLVE framework (EMF, 2013, 2015). However, at present such frameworks tend to be normative and conceptual. This means they are not grounded in how practitioners distinguish between circular strategies, and therefore it remains unclear how they can be used for generating and synthesising actionable knowledge for CE and how they can serve as the basis for analytical and methodological approaches to circular oriented innovation or COI (Brown et al., 2019). This lacking ability also complicates assembling best practices and contrasting and comparing case studies if new contributions are not clear, or not consistent, in what aspects of CE they cover. Illustrative in this regard is the recent special issue on circular business models (CBMs) (Fraccascia et al., 2021) published in this same journal, where Kanda et al. (2021) discuss industrial symbiosis, Franzò et al. (2021) primarily cover material-level interventions in single use packaging such as recycling, and Reim et al. (2021) study circularity in the context of heavy machinery with a large role for maintenance. All these invoke the concept of CE, but with very different approaches to defining *what is circular* about their study contexts. Currently, it is unclear how such contributions can eventually be compiled into a body of knowledge.

In sum, without specifying *why* circular strategies are seen as offering solutions, *what* (variations of) circular strategies are being examined, and *who* is envisioned to act the context is missing to position contributions from organisation science in relation to each other as well as relate it to other work in the domain of CE. Therefore, there is a need for the development of an analytical framework that adopts a systems perspective and is grounded in practice and that allows for the contrasting and comparing as well as the synthesis of insights into CE. This necessitates going beyond the current frameworks of CE and to add the empirical perspective through answering questions such as the following: Why engage in CE? What circular strategies are considered meaningful, and what relationships exist between them? Who is needed in the further development? But also, apart from material flows, what other flows are considered relevant when designing circular systems? And, how do circular solutions evolve over the course of designing and implementing them? In this work, we therefore examine how circular solutions are characterised or described by practitioners of COI.

Our objective is twofold: (1) to develop an analytical framework for CE that is grounded in both theory and practice, as well as (2) to demonstrate the application of such a framework to a wide range of different circular solutions and how this can lead to new insights and new directions for research. With this, we provide a foundation for further knowledge generation: a common starting point from which other work, both theoretical and empirical, can depart. Specifically, we develop an approach that is compatible with most frameworks and theories within organisation science—and that thus has the ability to serve as 'scaffolding' for creating and synthesising knowledge across different scientific contributions.

We cover the following. As umbrella concepts have a central role in advancing shared understanding, we ground our approach in the process of *meaning work*, where *action recipes* are of central importance. This grounding is used to derive the basis for the analytical framework as well as the research design. The following section presents the results of the cross-case analysis, providing insight into the different aspects involved in the formation of action recipes for CE. Next, our within-case analysis provides insight into the progression of the projects and the development of the sets of circular strategies over time. The paper concludes with discussing how the uncovered phenomena of circular pivots, minimal viable circular configuration (MVCC), continuous improvement of circular configurations and interactions between circular strategies provide insight into COI and how the created frameworks can be used within management and organisation science more broadly.

## 2 | THEORETICAL GROUNDING AND DEVELOPMENT: ACTION RECIPES FOR CE

Structural waste is hard for practitioners and academics alike to investigate, elucidate and innovate for—particularly if no shared understanding exists. To shed light on the creation of this understanding, we start with the basic principles of social embeddedness and socio-materiality, which we further expand on by drawing on *meaning work* which is further operationalised via the concept of *action recipes*. We then proceed with extending action recipes for CE using the frameworks of Resource States and the Big Five Structural Wastes to bring clarity and structure to the concepts of ‘resources’ and ‘waste’.

### 2.1 | Starting point: Organising resource flows

To start, we acknowledge the social embeddedness of resource flows (Boons & Howard-Grenville, 2009), and that this is an important source of inertia as well as change (Benford & Snow, 2000). It is “people that make flows flow” (Baumann, 2012), where actions are grounded in the ideas and assumptions about what is appropriate waste and resource management. This has long since been recognised by scholars within industrial ecology (e.g., Frosch & Gallopoulos, 1989; Graedel & Allenby, 1995; Socolow et al., 1994; Tibbs, 1993; White, 1994), in life cycle management (Lindkvist & Baumann, 2017; Nilsson-Lindén et al., 2021), in geography studies (e.g., Gregson et al., 2015; Gregson & Crang, 2015), in social science (e.g., Lounsbury et al., 2003; Silva et al., 2016) as well as in management and organisation science (e.g., Corvellec & Hultman, 2012; Hoffman, 2003).

This is in line with the approach to organising known as *socio-materiality*: Where the relationship between the physical world and people's lived experience is central to understanding real-world phenomena. This relationship is twofold: People shape the physical world around them, but the reverse is equally important. For CE, this means that people shape resource flows, and that in turn people's actions are

also shaped by those resource flows. Socio-materiality is represented by such scholars as Bruno Latour (e.g., Latour, 1993, 2005) and Barbara Czarniawska (Czarniawska, 2004).

Examining this recursive relationship between the physical and human can be done through drawing on the concept of *meaning work*—a phenomenon that plays a central role in both the framing (Goffman, 1974) and sensemaking literature (Daft & Weick, 1984; Weick, 1993, 1995; Weick et al., 2005). *Meaning work* is designated as signifying work or meaning construction (Benford & Snow, 2000): It describes the process that establishes, maintains and challenges an actor's understanding of the world. As part of this process “[people] vest objects, utterances, actions and so forth with subjective meaning” in order to “make their world intelligible” (Frost & Morgan, 1983: 207). Individuals, but also other actors such as organisations, undertake meaning work in order to assign structure and significance to events that allow for determining the status of these events in reality (Goffman, 1974). Through determining this, an actor comes to know what is ‘going on,’ whether or not this has relevance, and the manner in which to engage with an unfolding situation. For example, the same sequence of events can be described as a demonstration, a practice or an experiment.<sup>2</sup> Adopting either description results in a different assessment with regards to what it is that is ‘going on’ and how to behave or respond appropriately (Goffman, 1974).

A range of factors feed into the process of establishing meaning: the background of actors, the situational context, enactment, the cues present, the capacity to allow for (re)interpretation, etc. (Goffman, 1974; Weick, 1995). The goal of meaning work is to order these—and with it the experience of the world—into a coherent whole by determining what ideas, sense or understanding to adhere to when acting (Goffman, 1974; Weick, 1995). Meaning, work actively addresses ambiguity through selecting, filtering and assembling cues, and applying the learned or derived rules (explicit or implicit) as determined by the situational context. In day-to-day activities, great care is usually taken to ‘rule out’ ambiguity (Goffman, 1974). In meaning work, a meaning is considered valid as long as the stimuli acknowledged by the actor do not contradict an established meaning. As such, it is important to understand what actors consider meaningful and how they establish coherence. It is not necessarily about establishing what the world is ‘really like’. Instead, meaning work primarily serves to create ‘action recipes’ by establishing coherence between past experience, internalised concepts and new stimuli so that a basis for action is created.

### 2.2 | Action recipes for CE

Meaning work can be operationalised using the concept of action recipes (Benford & Snow, 2000). Action recipes shed light on meaning work through clarifying how ambiguity is addressed to enable action. *Action recipes* consist of internalised relationships between concepts and a set of actions (Benford & Snow, 2000); see Figure 1 (left). Actions are rendered coherent through the application of a particular logic or understanding to create internal consistency between past,

**Generic structure of Action Recipe**

after: Benford &amp; Snow (2000)

**Punctuation**

- Point to an issue of importance;
- Problematize the issue;
- Pose that the issue can be remedied.

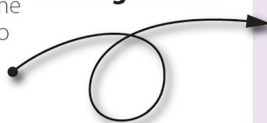
**Elaboration**

- Diagnosis
  - Identify the cause of the issue: naming one or more issues that cause or contribute to the issue.
- Prognosis
  - Suggest an outline of appropriate solutions.

**Motivation**

- Naming of party or parties within society that should act to address the issue and the provision of reasons why they should do so.

**Applied to  
waste & resource  
management:**

**Structure of a Circular Economy Action Recipe**

after: Blomsma (2018)

**Purpose**

- Point to salience of waste and resource management;
- Point to perceived waste and resource *mis*management;
- Propose that the issue can be remedied.

**Elaboration**

- Mechanism
  - Identification of what needs to change in the economy and/or industrial systems to conduct waste and resource management in a different manner.
- Perpetuation & Prevention
  - Identification of circular and preventative strategies that contribute to resource conservation, efficiency & productivity.

**Proaction**

- Identification of actor or actors that should act to implement the proposed solution and the provision of reasons why it is the responsibility and/or in the interest of these actors to do so.

**FIGURE 1** Action recipes explained and adapted for the context of CE

present and expected outcomes of those actions. How and why meanings are made to cohere and the dynamic nature of this coherence are important parts of understanding meaning work, and action recipes are therefore at the heart of meaning work.

For understanding CE oriented action recipes, we draw on and further extend the work of Blomsma (2018), who adapts Benford and Snow's (2000) framework for action recipes for the context of CE; see Figure 1 (right). Blomsma (2018) examined how circular strategy frameworks cohere. Examples of such frameworks are Cradle-to-Cradle™ (Braungart & McDonough, 2002), Performance Economy (Stahel, 2006), Blue Economy (Pauli, 2010) and Industrial Symbiosis (e.g., Korhonen, 2005; Lowe & Evans, 1995).

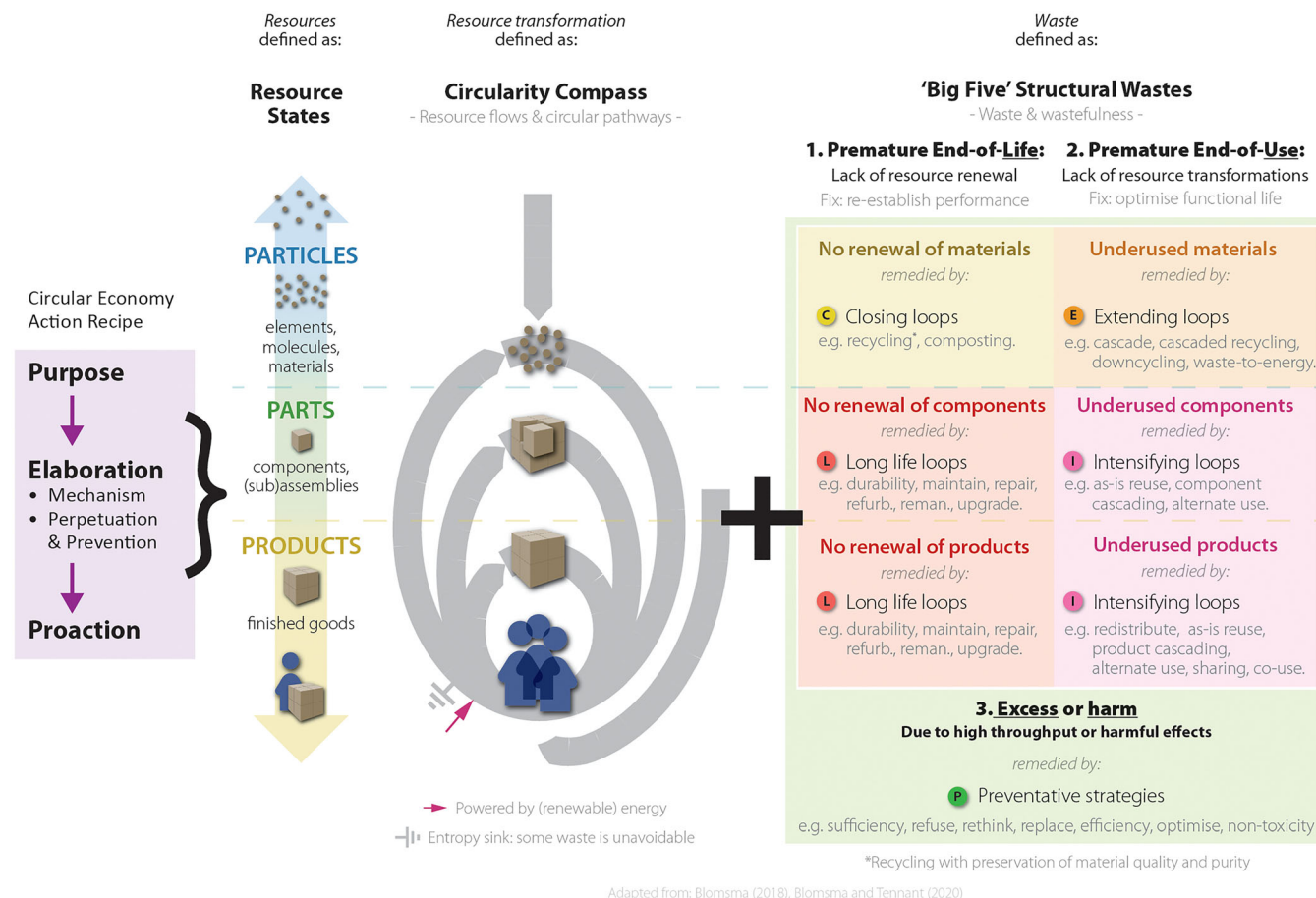
These frameworks cohere as a result of following a set of steps that generate action recipes for CE. These steps can be summarised as follows: (1) setting a *purpose*, (2) *elaboration* on the purpose through the identification of mechanisms that can bring it about, and (3) identifying and incentivising the actors of whom *proactive* participation is needed. First, the attention is directed to the importance of appropriate waste and resource management. The need for change is highlighted by identifying the presence of problems (pollution, climate change, etc.) or the absence of particular benefits (stagnating wealth, resource security, etc.). Addressing these problems or bringing about these benefits is the *purpose* of applying circular strategies: It constitutes the driver behind conducting COI. Next, one or more root causes are identified and linked to (sets of) circular strategies that are thought possible and appropriate, including any preventative strategies that are thought relevant. This constitutes the *elaboration* step: High-level actions are prescribed to bring about the improved

situation. Finally, the actors that should (also) act to implement the proposed solution are identified, together with a motivation for why acting is beneficial for them. This step can be designated as *proaction*.

Whilst Blomsma (2018) shows that the general structure of action recipes can be fruitfully applied to understand circular strategy frameworks, this structure does not yet allow for understanding two of the key concepts within CE, namely, *resources* and *waste*. Clarity around resources and waste is needed for understanding both the purpose and the elaboration steps, respectively: *Why* something is seen as problematic, as well as *what* circular strategies are perceived as solutions—and for both where in the system they play a role. For this, we draw on the Resource States framework, which allows us to create both the Circularity Compass and the Big Five Structural Wastes (Blomsma & Tennant, 2020); see Figure 2. The Resource States framework was conceived to capture the transformations of resources as they journey through the economy, from particles (materials), to parts (components), to products (finished goods) and onwards through various circular strategies. Adopting this life-cycle view, as further detailed by the Circularity Compass, allows for describing consumption and production systems in terms of how flows flow and how resources change form along the way. In essence, it allows for a qualitative assessment of resource flows and is thus related to other quantitative flow assessment methods such as material flow analysis (MFA) and Sankey diagrams.

The Big Five, which also uses the Resource States framework as its organising structure, was created to identify various types of waste and to link this to circular strategies that can address it (Blomsma & Tennant, 2020; Blomsma & Brennan, 2022). The Big Five allows for





**FIGURE 2** Unpackaging circular economy-oriented action recipes by adding detail to what 'resources' are being made more circular as well as what 'waste' this addresses

understanding of 'waste' by naming both clearly visible as well as more inconspicuous types of waste by distinguishing between end-of-life and end-of-use for materials, components and products. With this, it extends the concept of waste beyond its colloquial use—usually limited to a generic reference to something 'thrown out' or 'discarded'.

Together these frameworks allow for mapping which circular strategies are considered relevant by COI practitioners and how this is rendered coherent. Following the structure of action recipes, and using the Circularity Compass and the Big Five for clarifying the role of resources and waste, we can now examine how COI practitioners deploy CE actions recipes, how they are rendered coherent and how they develop by asking:

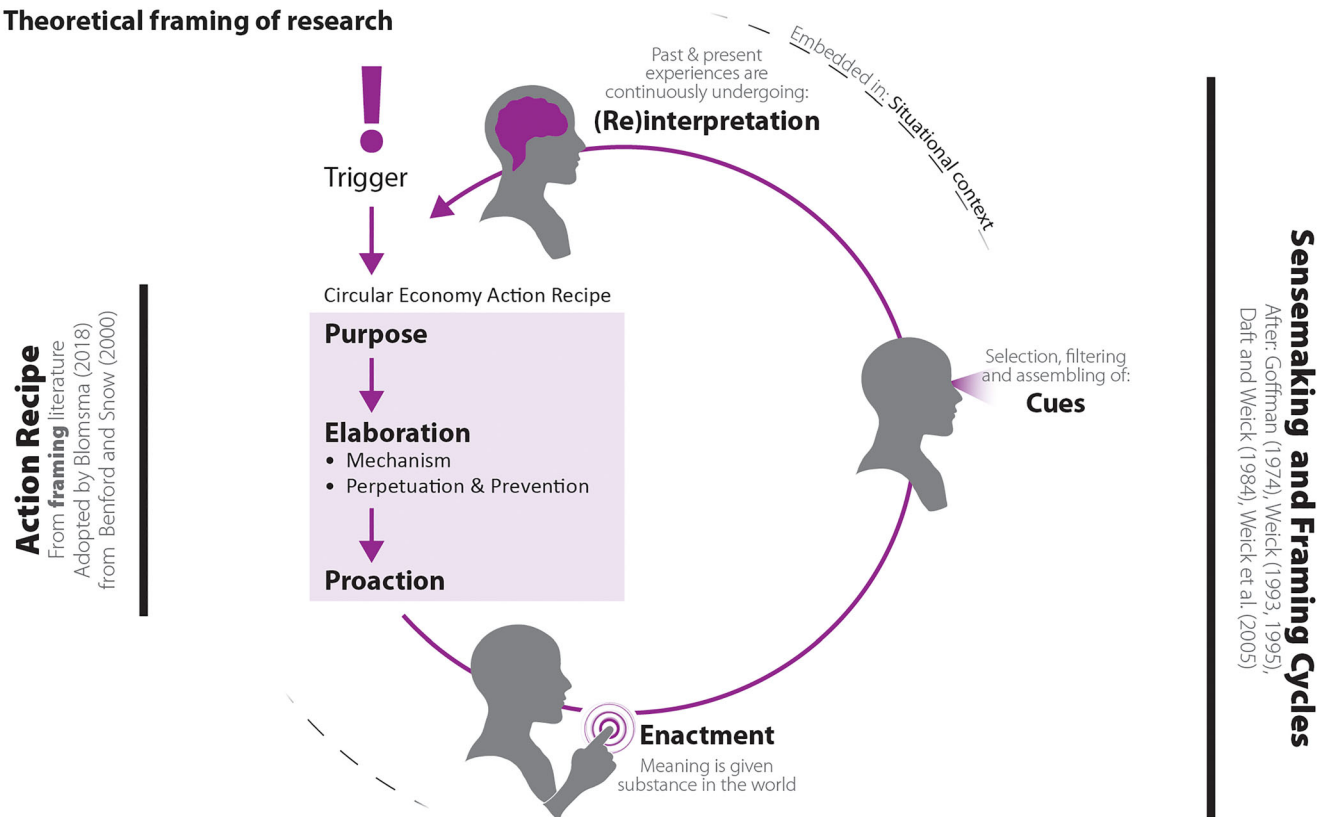
1. **Purpose:** What are the drivers behind the need for change, or what is the motivation to engage in COI? (Which wastes are present, and where are they?)
2. **Elaboration:** How are circular strategies envisioned to address the perceived issues? (Which circular strategies are applied, and where?)
3. **Proaction:** Who should (also) act to implement them? (Which actors?)
4. **Temporal:** How do action recipes for CE change over time?

### 3 | RESEARCH DESIGN

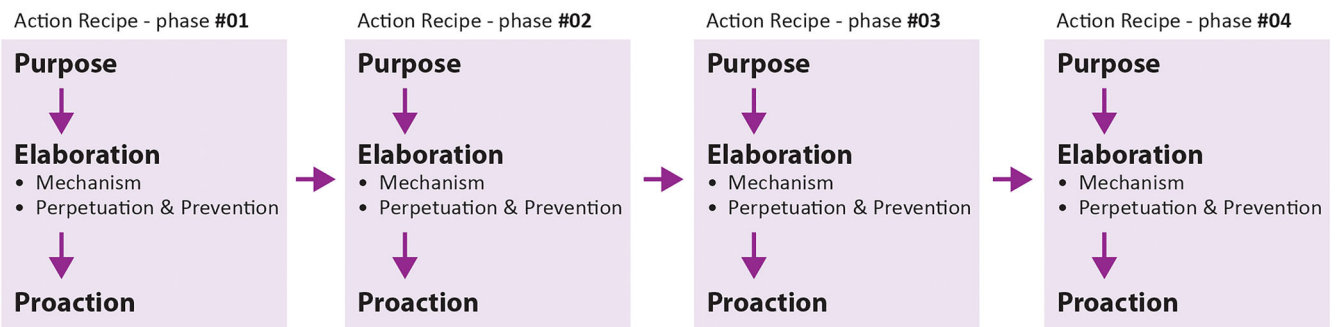
For understanding how action recipes for CE can best be studied, we briefly examine two other key characteristics of meaning work; see also Figure 3. First, meaning work is contextual, emergent and an active effort on behalf of actors (Goffman, 1974; Weick, 1995). It is a process that is materially, cognitively and socially embedded. Since the material and social circumstances of situations will differ, meaning work can be considered as a situated or contextual effort. Moreover, stimuli from a given context are not passively processed by actors. Stimuli are generally such a rich, varied and complex stream that they cannot be taken in and considered all at once in real time. Instead, actors cope by filtering them: Some stimuli are separated from the stream and become cues whilst others are 'disattended' (Goffman, 1974: 202). It is in this sense that actors actively shape meaning work. This characteristic of meaning work makes case study research particularly suitable as case studies allow for understanding a phenomenon embedded in its context. This as opposed to focussing on the conceptual mental models individuals hold regarding hypothetical applications of CE.

Second, meaning work is processual and enacted in nature (Goffman, 1974; Weick, 1995). It is always on-going (Weick, 1993): It

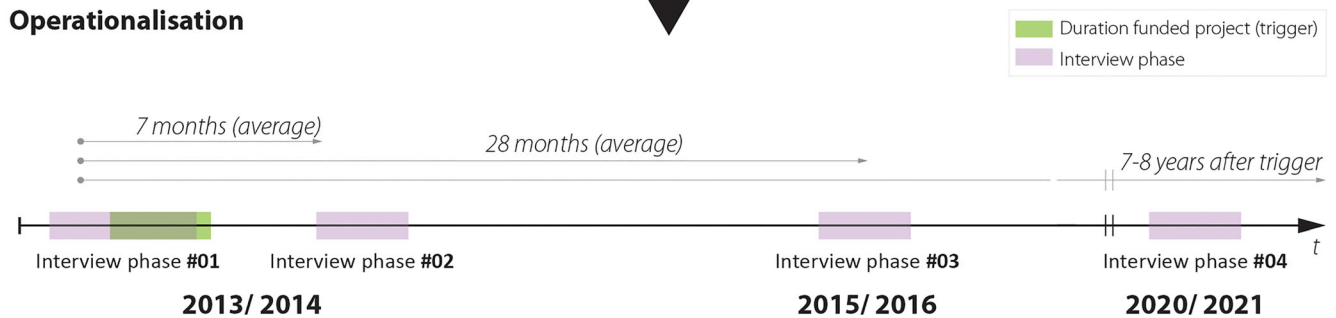
## Theoretical framing of research



## Implications for research design



## Operationalisation



**FIGURE 3** Research design

never truly begins, and never truly stops. Nevertheless, one can identify 'triggers' or events that can be taken as starting points. This furthermore implies that meaning work produces dynamic outcomes.

Past and present experiences are continuously interpreted and—crucially—reinterpreted. This means that cues previously assigned one meaning can, as a result of new information becoming available be

assigned a different meaning. The understanding of what is 'going on', moreover, produces the environment in which action takes place through enactment by giving the meaning substance in the world. In this sense, meaning work is recursive—action and cognition are co-dependent—and can even be self-fulfilling. Action recipes thus typically evolve over time, as more is learned and meaning is negotiated between actors (Benford & Snow, 2000). Therefore, action recipes for CE should be regarded as dynamic entities. This characteristic implies that one-time snapshots are insufficient to understand CE meaning work.

These considerations led us to a longitudinal qualitative case study design. Specifically, we focus on business-led COI projects. To maximise coverage of different circular strategies as in line with the richness of the CE concept (Blomsma & Brennan, 2017), a multi-case study design was chosen, involving 15 interviewees, covering innovation projects of 23 product(s) (groups) for 19 focal companies. Cases were recruited via InnovateUK (formerly: Technology Strategy Board), a funding body in the United Kingdom that aims to stimulate and support business-led innovation. CE themed bid competitions were run to provide businesses with the means to explore key aspects of a proposed product design and/or a business model idea aligned with CE and included an assessment of the feasibility and desirability of commercialization of the proposed idea (IUK 2013). The cases explored possibilities to increase the circularity of electric devices, products related to housing and living, display and presentation and a range of other product groups, and covered a range of circular strategies from waste prevention, to reuse and upgrading.

To account for the dynamic nature of action recipes for CE, data collection was conducted in four phases; see Figure 3. The bids facilitated exploratory projects of 2–3 months during 2013, some of which were extended into early 2014 for a total duration of 6 months (duration as reported by participants). During Phase 1 of data collection, the funded part of the project was about to start or was underway. A second round of interviews was conducted 7 months after the initial funded part of the process had ended (on average). A third round of interviews was conducted 28 months (on average) after the first interview, taking place in late 2015 and early 2016. As such, these phases covered the early stages of CE oriented innovation, including experimentation and piloting of proposed innovations (Weissbrod & Bocken, 2017). During April 2020 and July 2021, a follow-up was done as it had come to light that some projects previously classified as 'on hold' had now been implemented. This prompted an investigation with regards to the status of the cases 7–8 years after the start of the initial exploratory projects. All previous cases whose projects did not terminate after the second and third interview phases were contacted again. Due to the Corona crisis and new project leads, this phase of data collection covered 10 interviewees and 10 product(s) (groups).

The main sources of data were semi-structured life world interviews (Brinkmann & Kvale, 2015). Interviews for the first three phases were recorded and transcribed. Complementary material such as project summaries, (part of) the project proposal, (part of) the final project report and project videos were also collected. All data were collated and structured using the action recipe steps *purpose*–

*elaboration*–*proaction* introduced in the previous section. The resulting visual mappings, created using Adobe Illustrator, were used for the analysis, facilitating comparing and contrasting of cases. This allowed for iteratively developing the Circularity Compass as salient differences and similarities were identified; see Appendix A, Figure A1.

Also, for the fourth and final interview phase, primarily semi-structured life world interviews were used, with variations. That is, one interview was done via the LinkedIn chat function. Moreover, in four cases interviews were with a different person, due to progression of or changes in the project, or job changes. This could be accommodated given that the unit of analysis was the action recipe for CE of the projects. Complementary materials such as company websites, news reports and promotional videos were likewise collected for this phase. See Appendix B for an overview of cases, interviewees and companies in each phase of the research and Appendix C for an overview of the data collected per case.

Cross- and within-case analysis was applied. Cross-case analysis was used to examine how action recipes for CE are rendered coherent across the dataset. Within-case analysis tracked the progression of the understanding of the problem situation and the proposed solution for the duration of the research. See Appendix A and Blomsma (2016) for more detail with regard to data collection, processing and more detailed case mappings. Simplified case mappings are included for the purposes of this paper. The following results section will discuss the cross- and within-case analysis in turn.

## 4 | RESULTS

The following section presents the results of the cross-case analysis, providing insight into the different aspects involved in the formation of action recipes for CE. Next, our within-case analysis provides insight into the progression of the projects and the development of the sets of circular strategies over time.

### 4.1 | Cross-case analysis: Mapping cases in detail

We follow the structure of action recipes to organise our discussion of the insights in the below, starting with 'purpose'. See Figure 4 (top and bottom) for simplified examples of case mappings that were created to aid analysis: The figures respectively describe the problem situation (left) and the proposed solution (right) for Cases #01 and #09 by means of illustrative examples.

#### 4.1.1 | Purpose: The driver behind the need for change—which wastes are present?

The problem situations that the cases aimed to address had in common the presence of multiple structural wastes and multi-dimensionality. See the red circled area(s) on the left side of the case mappings in Figure 4. Take, for example, Case #01. One primary type



## Case examples

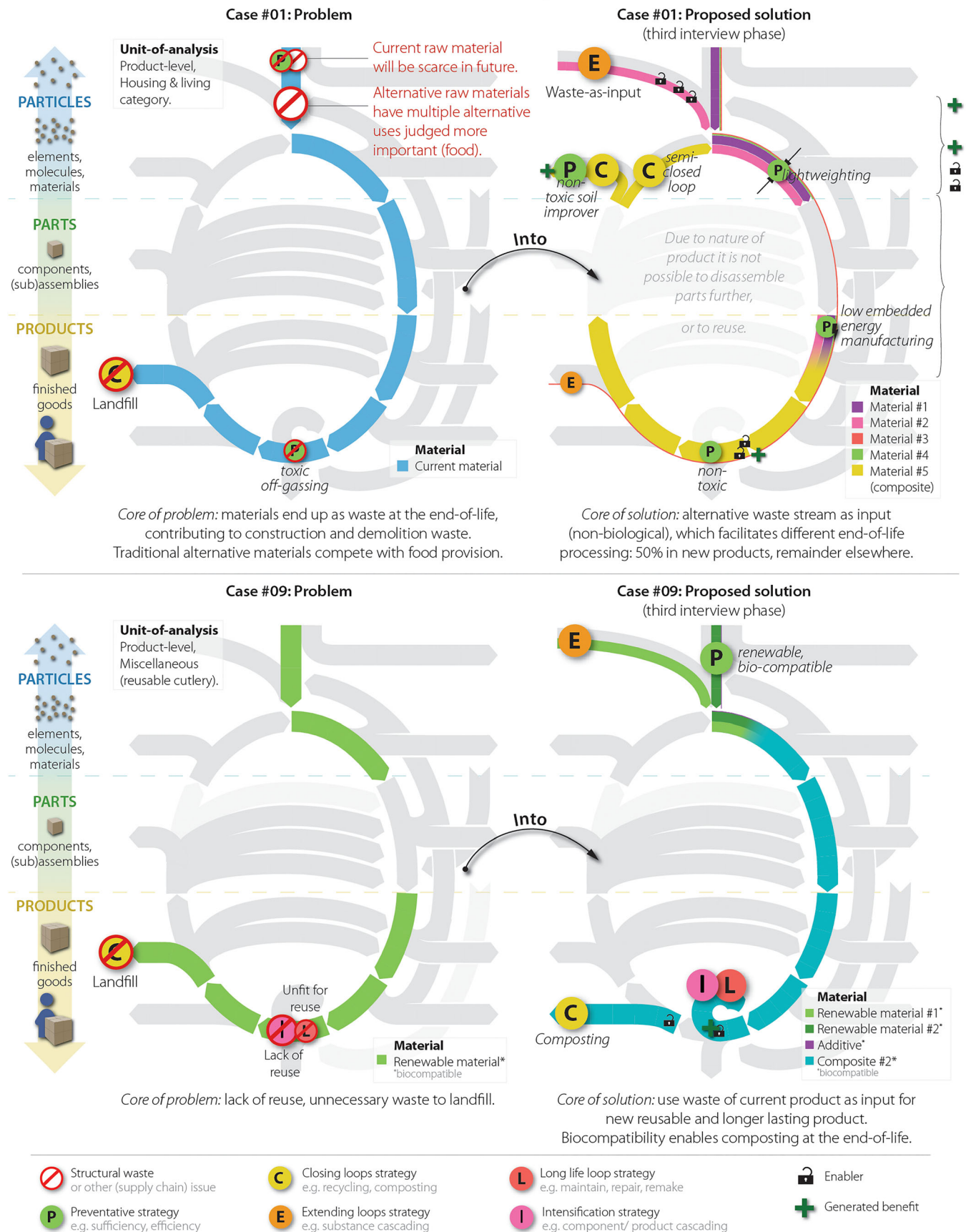


FIGURE 4 Examples of case mappings, depicting the proposed solution

of structural waste was identified: The current product contributes to construction and demolition waste going to landfill. The fact that virgin raw material was being used, whilst at the same time, another plentiful waste stream existed was also thought of as problematic. In addition, the current product contributes to toxic off-gassing in the indoor environment under certain circumstances. As such, both a lack of closing loops and preventative strategies were identified. Moreover, the interviewee described additional issues: how for various alternative replacements for the raw material other and more important uses exist, among which was food production. The interviewee furthermore commented on the association of some of these alternatives with (armed) conflict and/or how they can ignore the local availability of materials.

Through the proposed solution Case #01 aimed to address these combined issues, as the use of the waste stream would prevent it being landfilled and also substitute a virgin raw material. The material properties of the new material were thought to enable different end-of-life processing (further explored as part of the project), and this furthermore meant that off-gassing would no longer take place. The new product would differentiate itself in the market through its sustainability and recyclability credentials, thus appealing to new customers. In addition to this, due to lower material density and innovative manufacturing processes, the participant expected the new product to generate higher margins for the focal company than the current alternative.

Case #09 similarly contained multistructural waste types. Here, as the case involved a single-use product, the current situation was seen as a lack of reusable solutions (underused product) because it was unfit for this purpose (lack of durability), which contributed unnecessarily to landfill (no renewal of materials). The proposed solution also (initially) relied on using waste as an input, combined with renewable and bio-compatible virgin inputs. Because the new product would be more durable, convenient and appealing to users, it would facilitate reuse. Moreover, due to the formulation of the product, it could be safely composted at the end-of-life.

In short, the drivers behind the COI projects recognise multiple types of structural waste and can, in addition, include a range of other problems seen in value chains. In their analysis, interviewees articulated issues in the forward part of the value chain, the use phase as well as in the reverse chain. That is, participants considered the value chain as a whole and could identify multiple pain points and/or missed benefits across it. Their solutions aimed to address these as an integral part of their circular solution. It can thus be said that the participants took a systemic outlook on their projects and that they set out to address a complex set of goals. A possible explanation for this is that the participants attempted to build arguments for their projects that would appeal to different stakeholders.

#### 4.1.2 | Elaboration: How are circular strategies envisioned to address the perceived issues?

Next, we examine the proposed solutions: See also the example cases in Figure 4 (right side). We discuss the next iteration of the Circularity

Compass that was created in more detail and the insights it generated into how the motivation is further elaborated upon through circular strategies that remedy the problem situation. A need furthermore arose to describe the role of other flows in generating circular action recipes, for which the multi-flow metabolism (MFM) was created.

##### *Circularity Compass*

The new Circularity Compass, see Figure 5, contains three circular strategies that are typically not part of circular strategies frameworks. The first is *reconstitution*: This strategy refers to the flexible use of a product's value delivering capacity by dis- and reassembling it as required and through this giving the product different features or functionality. The possibility for creating different configurations is defined within narrow boundaries: Components fit together in a limited and predefined number of positions, which limits the range of applications of functions the product can be used for. *Reinvention*, on the other hand, allows for the product and its properties to be created anew. Here, the boundaries for creating different product configurations are primarily defined by the limits imposed by the connections of components: The overall shape of the product can look radically different from one cycle to the next. Third and last is the identification of *co-used flows*: material flows that are not contained in the product, but that are used with or by the product, such as consumables or water and chemicals required for cleaning.

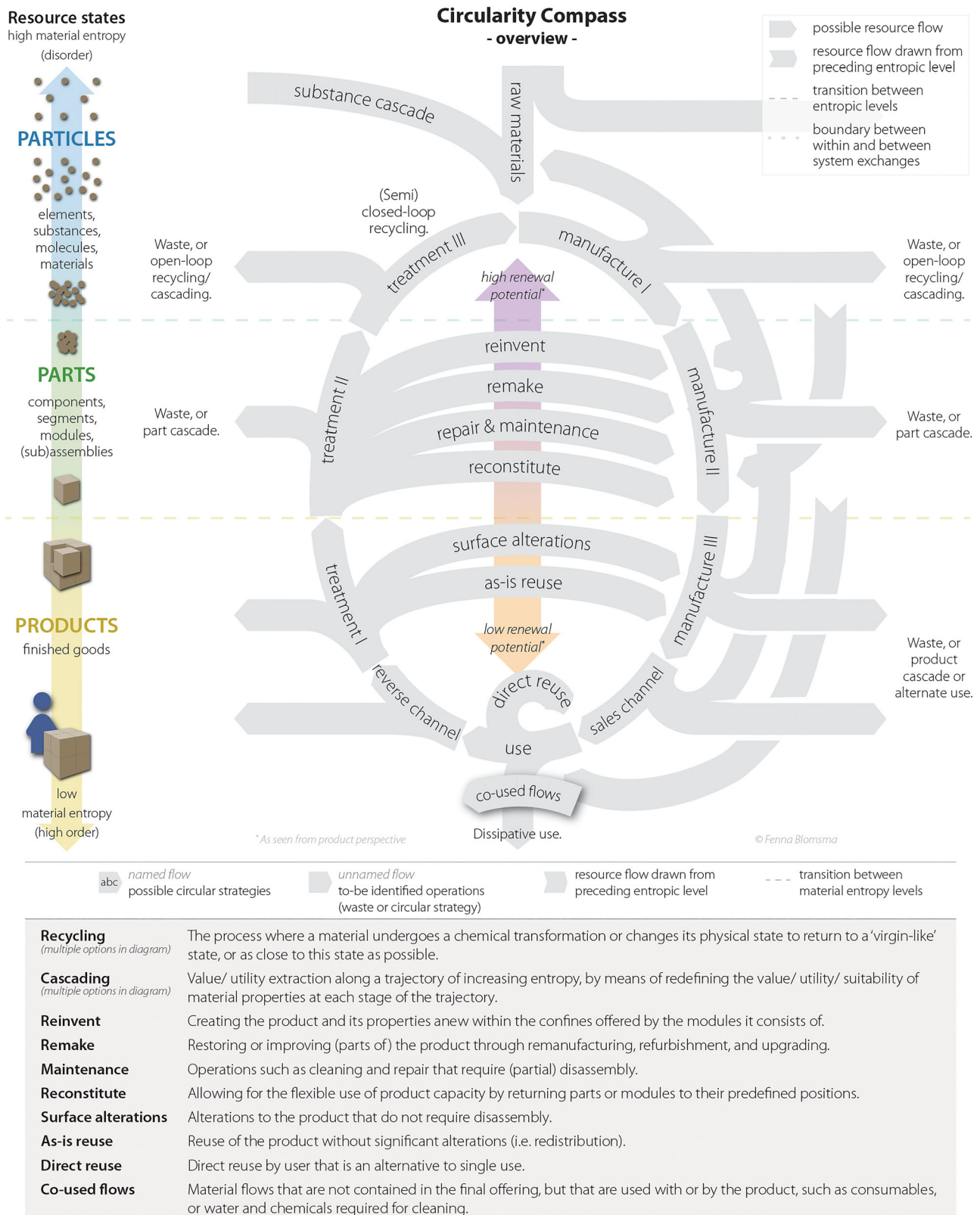
Comparing case mappings, see Table 1, it is evident that interviewees considered circular strategies across all three resource states. That is, participants typically considered and examined circular strategies affecting materials, components and products in their process. Considerations affecting the parts state were particularly important.

In addition to this, the solutions that interviewees pursued consisted of at least two or more circular strategies; see Table 2 and the examples of Cases #01 and #09 in Figure 4 (top right and bottom right). We refer to the co-occurrence of two or more circular strategies as *circular configurations*: situations where two or more circular strategies are present and where interactions—synergies, trade-offs and competition occur between them. In these situations, synergies between strategies are actively sought, trade-offs consciously managed, and competition avoided where possible. Table 3 gives an overview of the cases that aimed to alter or expand an existing circular configuration (10 cases) and the cases that aimed to create one (13 cases). That is, in COI it is likely that multiple circular strategies will be deployed, and that they are deployed across resource states.

As part of managing waste and resource flows, considerations regarding infrastructure and logistics also featured. Think of, for instance, the cost and environmental impact of shipping, the creation of infrastructure to generate a return flow of resources, or how existing infrastructure such as the postal services can be used.

##### *Multi-flow metabolism*

In many cases, considerations featured that were important, but that could not be placed on the Circularity Compass, as they did not directly relate to physical resource flows. Therefore, a second and related framework was created to capture these additional flows; see



**FIGURE 5** Circularity compass expanded and explained

Figure 6 and Table 3. Participants explicitly acknowledged the importance of energy, information and value flows, and either sought to access existing infrastructure to facilitate these flows or to create new

infrastructure to enable this. This complementary framework is titled the MFM, and it depicts the different types of flows as the layers or levels of a system. The Circularity Compass is included in Figure 6 in

**TABLE 1** Role of resource states in the cases of the 23 product(s) (groups)

Cases involving considerations regarding the:		
	Particle state considerations play key role	<b>8</b>
Particle state	Case numbers	#01, #06, #08, #09, #13f1, #13f2, #15i, #15
	Particle state plays a supporting role	<b>9</b>
(materials)	Case numbers	#02, #03, #05, #10, #11a, #11b, #12d, #14 h, #15j
	Part state plays new role in forward chain	<b>2</b>
Part state (components)	Case numbers	#02, #09
	Part state plays new role in EoL value chain	<b>9</b>
	Case numbers	#02, #03, #05, #08, #11a, #11b, #11c, #12d, #12e
	Part state takes on new significance	<b>2</b>
	Case numbers	#10, #14h
	Part state 'designed out' for EoL	<b>1</b>
	Case numbers	#15j
Product	Product state plays a key role	<b>15</b>
State (finished goods)	Case numbers	#01, #02, #03, #04, #05, #08, #09, #11a, #11b, #11/12c, #11/12d, #13f1, #13f2, #15k, #15l
	Product state provides constraints only	<b>6</b>
	Case numbers	#06, #07, #12e, #14g, #15i, #15j

Note: Numbers in bold indicate the total number of cases; numbers preceded by '#' indicate specific cases.

the bottom layer, to indicate the relationship of resource flows with these additional flows.

Energy flows, for instance, played a role in seven cases. The primary concern regarding energy flows was to reduce them as much as possible and to not create rebound effects where resources are more circular, but they require more energy during use or reverse logistics, negating any benefits created through (increased) circularity. Local and green energy generation was also explored in one instance, as

**TABLE 2** Role of circular strategy configurations within the 23 product(s) (groups)

Alter or expand current circular strategy configuration	<b>10</b>
Case numbers	#02, #03, #04, #06, #10, #11a, #11b, #12e, #14h, #15j
Create or build circular strategy configuration	<b>13</b>
Case numbers	#01, #05, #07, #08, #09, #11/12c, #12d, #13f1, #13f2, #14g, #15i, #15k, #15l

Note: Numbers in bold indicate the total number of cases, numbers preceded by '#' indicate specific cases.

**TABLE 3** Important role attributed to other flows

Energy flows		7
Cases (instances)		#01, #02 (2x), #04, #06, #10, #11a (3x), #11b
Information flows		12
Cases		#01, #03, #09, #10, #11a, #11b, #11/12c, #11/12d, #14h, #15i, #15k, #15l
Value flows	New business model	8
Cases		#02, #03, #04, #11a, #11/12c, #12d, #14g, #14h
	Additional benefits	17
		#01, #03, #04, #05, #08, #09, #10, #11a, #11b, #11/12c, #11/12d, #13, #14g, #14h, #15i, #15k, #15

Note: Numbers in bold indicate the total number of cases; numbers preceded by '#' indicate specific cases.

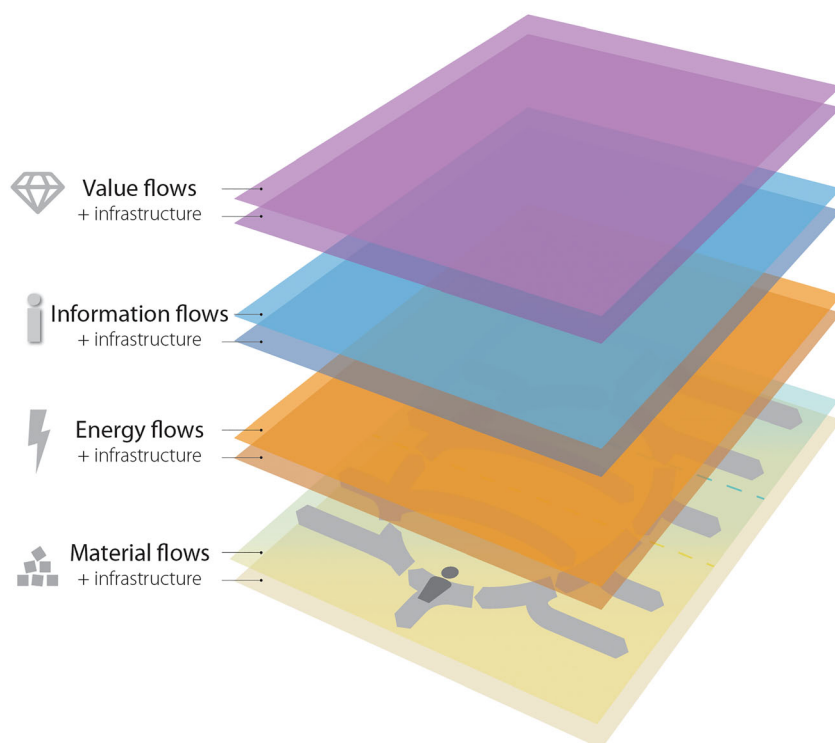
part of the manufacturing facility (e.g., creation of energy infrastructure).

Information flows were seen as salient in 12 cases: They were to enable the envisioned resource flows either through making information regarding life cycle options available to the right stakeholder at the right point in time and to enable benefit sharing or claiming incentives, such as refunds or discounts. As part of the information infrastructure, for instance, this included the use of scanning devices, apps or websites, often coupled with an information carrier in the resource that would make information available to stakeholders at the appropriate life-cycle stage. Think of (chemical) barcoding, (personal) information stored in or accessible through an app, etc.

Value flows were important in two ways. For one, eight cases explored a change in the business model, allowing for capturing new or additional value. Second, 17 cases considered the generation of benefits that make the offering (more) attractive for stakeholders.



## Multi-Flow Metabolism



**FIGURE 6** Visualisation of the multi-flow metabolism

Think of improving the margin of a customer or supplier on an offering, enhancing aspects of the offering for the customer (e.g., convenience, fun and safety), or making manufacturing quicker and more efficient. Likewise, new value infrastructure needs to be in place to enable capturing this value, such as new payment and financing mechanisms.

#### 4.1.3 | Proaction: Who should (also) act and why?

Via *proaction*, it was examined which actors' cooperation was deemed required in implementing the proposed solutions (actor mapping omitted from simplified mapping in Figure 4; see for full mappings Blomsma, 2016). This provided insight into where participants were dependent on other stakeholders, and therefore indicates areas to manage risk, seek collaboration or exercise influence. This can be done through wielding any direct power the organisation may hold, through the application of relational capital (Brennan, 2016), or through the formation of partnerships and consortia.

At the time of the second phase of data collection, of the 22 proposed redesigns still considered desirable, 20 had turned the attention from the (technical) development of the proposed solutions to considering stakeholders in the innovation process, whether internal or external to the focal company, in order to generate the financial means and political support to continue development or implementation of the proposed solution (the remaining cases being either terminated, choosing internal development or the next steps being unclear).

In the third interview phase, it became evident that these efforts proved challenging. Many projects encountered difficulties progressing that stemmed from value network dependencies. For example, suppliers going out of business or being struck by long-term inoperability of facilities, suppliers unwilling to experiment and engage with production on smaller scales, unable to find either suppliers or customers with similar priorities, a competing patent pending, etc. Moreover, such difficulties can also be the result of lack of support from internal stakeholders, such as a CEO change, which can change innovation priorities and as a result invalidate subsequent COI efforts.

This, in contrast with, for example, Case #07, is a project characterised by early collaboration, co-creation of solutions and a clear articulation of shared value. This could point to the importance of projects having buy-in from multiple management layers within businesses as well as across businesses to progress successfully.

Two participants, however, noted their deliberate choice to not involve too many stakeholders too soon. That is, they expected that involvement at a stage where solutions had not yet taken sufficient form would either disengage stakeholders due to focusing the attention on a problem they are not yet currently prioritising or that this would force the solution in a direction that would not lead to its optimisation. When and under what conditions to actually involve which stakeholders is still an open question in COI, but a minimal requirement for COI could be to perform an early risk scan or assessment on behalf of the stakeholder to at least create awareness of potential issues. Such an assessment should involve such factors as physical risk (e.g., lack of supply/lack of facilities for processing), and alignment risk (different perspective on problems and solutions).



TABLE 4 Status of proposed solution after 28 months

Status	Number of cases and status at interview phase #03 (2015–2016) Case number and reason for status (total of 23 cases)	Number of cases and status at interview phase #04 (2020–2021) Case number and reason for status (total of 10 cases)
<b>Implemented</b> Solution commercialised	<b>1</b> #15j: Support from customer drove implementation; in the process of scaling up implementation	<b>4</b> #02: Change from modular reuse system (reconstitution), to a focus on using recycled content and supporting customers with end-of-life recycling solutions (based on LCA) #07: Two commercial facilities operating at scale, various licensees, exploring new directions for scaling #08 m: Original focal company has implemented several circular strategies, including use of biomaterials, Recycling and composting, but not reuse #09: Refocused around new set of circular strategies: Instead of waste-as-input, compostability and reuse <sup>a</sup> , to reuse <sup>a</sup> and recyclability.
	<b>2</b> #07: Partnership continued for further development, prototypes produced, trial due to commence #11a: New partnership formed for further development, prototypes produced, trial due to commence	
	<b>3</b> #04: Found and pursuing other niches to develop solution #05: Developing technology application in a different niche #10: Local project superseded by centralised effort	<b>4</b> #01: After two preceding pivots, a new partners/ customer has been found as well as a new application for the material has been found which a shift in the circular strategies from waste-as-input <sup>a</sup> and recycling/composting to waste-as-input and longevity <sup>a</sup> #08n: Participant is looking to restart reuse and biobased solutions in new consortium #10: Recent restart after hiatus, driven by renewed interest in CE by HQ & previously identified drivers reasserting, considering new focus (e.g. focused on spare parts) (potential circular pivot) #11a: Exploring options, but focusing on a new market segment and with a focus on different circular strategies:
	<b>9</b> #01: Awaiting customer engagement for further development #03: Awaiting customer engagement/other funding opportunities for financial support #08: Exhausted some but not all possibilities to interest potential commercial parties in further developing solution: Participant intends to persevere with concept #09: Awaiting other funding opportunities for financial support/motivation to return #11b: Awaiting a suitable time to review implications of existing patent & residual value of design #13f2: Next steps remain unclear, plus lack of financial means #15i, k, l:	<b>1</b> #05: Return to original idea, looking for new opportunities to restart the project
	<b>On-going</b> Active efforts to further develop	
<b>On-going &amp; development in different direction</b> Proceeds in other niche or on a different scale		
<b>On-hold</b> Intention or desire expressed to continue development of solution in future, although precise time uncertain		

(Continues)

TABLE 4 (Continued)

Status	Number of cases and status at interview phase #03 (2015–2016) Case number and reason for status (total of 23 cases)	Number of cases and status at interview phase #04 (2020–2021) Case number and reason for status (total of 10 cases)
<b>Terminated</b> No intention for further development	Unclear if customer can be found	
	2 #06: Material targeted inadequate for meeting product requirements #13f1: Terminated cooperation with designer of product	1 #03: Outcompeted by different circular strategy (e.g. digitalisation)
<b>Uncertain</b> No new developments To report	5 #11/12c: No new information uncovered from p. #12, p. #11 not aware of any new developments #11/12d: No new information uncovered from p. #12, p. #11 not aware of any new developments #12e: No new information uncovered from participant #12 #14 g & h: Participant not aware of any new development	1 #04: Ongoing until 2019: Participant now no longer directly involved
N/A	4 #02: Unavailable #12c-e: Unavailable	- -

<sup>a</sup>Anchor strategy: a circular strategy that constitutes the core of a circular approach/circular configuration. This can be supplemented by supporting strategies: strategies that further enhance the circular configuration. Numbers in bold indicate the total number of cases; numbers preceded by # indicate specific cases. GREEN: Change in circular configuration or circular pivot.

## 4.2 | Within-case analysis: From start up to 7–8 years later

Table 4 gives an overview of the project status at the third and fourth round of data collection. At the third round of a total of 23 unique solutions that were investigated, only one solution was implemented. Of the remainder, two were terminated, five were still in development (albeit some in a different form), nine were on hold, and of a further six solutions, no new information was uncovered. The latter was due to Participants #02 and #12 not participating in the third phase of interviews and Participant #14 not having been in contact with the focal company since the second round of interviews. The large proportion of on-hold projects is a striking result in the light of the earlier expressed feasibility and desirability of the proposed solutions and the pressing need to implement CE.

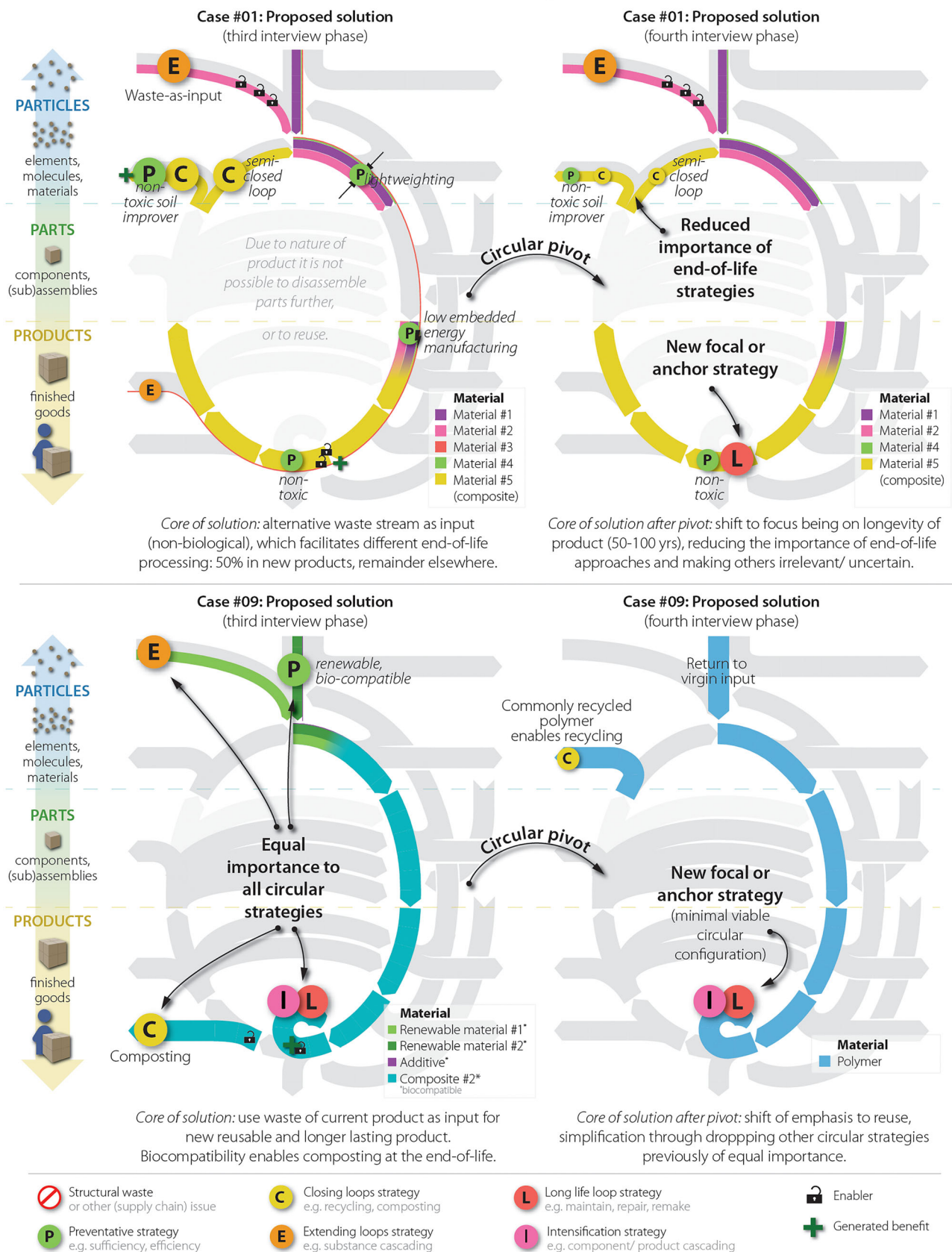
One possible explanation could be that, over the course of the first three rounds of data collection, few changes in the set of circular strategies were observed. That is, with the exception of Cases #11a and #13, participants tended not to change the circular strategies or the resource states targeted, although the relative importance of specific strategies within resource states was clarified and detailed over the course of the projects. In meaning work terms, the *purpose* and how this was *elaborated* upon were not reexamined. The lack of such course corrections or pivots (Ries, 2011) is salient, as they are common and often needed in the early stages of innovation projects as more is learned about both the problem and solution spaces.

The importance of such a deliberate approach to circular strategies was affirmed during the fourth interview phase, where it was found that of the 10 (or: 11<sup>3</sup>) follow-ups—four cases were now implemented (#02, #07, #08m, #09), four developments were ongoing but in a different direction (#01, #08n, #10, #11a) and one on hold, none terminated, and one uncertain—six had now changed the set of circular strategies included or had set priorities with regards to which ones to implement first.

In Case #01, for example, the project was now at its third iteration compared to the start in 2013; see Figure 7 (top). Crucially, this involved both traditional ‘pivots’ (e.g., change in direction through focusing on different market segments, or a new need) but also ‘circular pivots’: a significant change in the type or role of circular strategies that changes the nature of the circular configuration. Specifically, where the first concept revolved around waste-as-input (main or anchor strategy) and a combination of recycling and composting at the end-of-life (supporting strategies) as well as various preventative strategies related to embodied energy and amount of material needed, the new approach placed central importance on longevity (50–100 years) with the role of the previous strategies still relevant but recast as additional or supporting circular elements. It was these pivots that allowed the project to restart.

Similarly, in Case #09, see Figure 7 (bottom), previously ‘on hold’ and now implemented commercially, a ‘circular pivot’ was also instrumental to its eventual realisation. Previously, the approach attached equal importance to reuse (replacing single use) as well as using a biological waste-as-input and ensuring that the end-result could be safely

## Case examples



**FIGURE 7** Examples of a circular pivot. Continuation of Figure 4: Interview Phases 3 and 4 depicted here. For earlier phases, see Figure 4

composted through using for the additional materials virgin biocompatible materials and additives. Now, reuse is the primary circular strategy, which is supported by recycling at the end-of-life. This was enabled through a renegotiation in the project team with regards to what strategies are 'truly' circular. That is, the new project lead regarded using waste-as-input as validating another industry's waste and did not wish to connect the solution to this. The new solution is now available both for sale as well as part of a product-service system that covers a range of reuse solutions (with different variations with regards to the exact business model).

Lastly worth highlighting is Case #11a, as one of the cases with the most dynamic set of circular strategies. Initially, the project set out to enable upgrading through modular design. At the same time, this would facilitate longevity of a significant part of the product as well as enable a pure recycling stream of rare-earth materials. Central to this strategy was that upgrading enabled the product to become more energy efficient over its lifetime. First, upgrading was to be done by the customer at the location of use, which was later changed to involving the return of the product to a dedicated facility, necessitating an entirely different set of capabilities of the value network than the former. In 2017, however, due to the technology already being sufficiently mature to negate the benefit of upgrading, the focus again shifted to longevity, being advertised as "the only [product type] you'll ever need to buy." Conversations with a potential partner were ongoing when the Corona crisis necessitated a pause. Now, in 2021, the situation has changed again. That is, the participant indicated that changes in consumer behaviour and preferences necessitate a decision with regards to how to move forward with this project. In the meantime, however, another market segment has come into focus. The same solution initially developed for the consumer market could be deployed in this business-to-business segment with minor modifications. This pivot, due to the industrial use of the product in this context, would also entail another circular pivot that returns to the earlier focus of upgrading. This example highlights the difficulties CBMs have designing for the future, and dealing with uncertainty previously also identified by Linder and Williander (2017).

Note that a revision of the circular configuration does not always have to involve a radical change in the nature of the circular configuration or that previously conceived strategies need to be put aside entirely. In Case #13, for example, the participant indicated considering the possibility to design the proposed solutions by use of cascaded substances only, which meant dropping the end-of-life take-back and revisiting the recycling of product at a later stage, when revenue from sales was being generated. That is, COI can involve determining a 'MVCC' the set of circular strategies that effectively addresses structural waste, whilst offering the most pragmatic way towards implementation. In addition, COI can involve a 'continuous improvement' mindset, where the current circular configuration is designed in such a way so that future circular strategies can still be added.

Case #03 furthermore illustrates the importance of keeping sight of potentially competing circular strategies. That is, the solutions proposed in this project relied on 'reinventing' a product anew for every application, enabled by a modular design. However, after the project

was completed, the market developed in a different direction. The market for this product, designed for display and presentation purposes, steeply declined as a result of marketing activities moving online. As such, dematerialisation made the reuse approach redundant.

It seems that circular pivots, MVCC, continuous improvement and interactions between circular strategies are particularly important the more the system has to be redesigned. That is, when the proposed change is of an increasingly systemic nature. Case #07 is illustrative in this regard. This case revolved around reusing a post-consumer waste stream that was contaminating municipal waste streams and making them unrecyclable. This case differs from Cases #01, #09, and #11a in that the location of the intervention is clear, and apart from changing disposal habits, it does not involve further changes in practices or behaviour, or changes in the cost or incentive structure on the part of the customer. As such, even though projects such as Case #07 constitute tremendous improvements, the intervention itself is less radical than those of Cases #01, #09, and #11a.

Case #07 also provides insight into the importance of collaboration and co-creation. Specifically, for this case, how large multinationals can innovate together with smaller companies and how through this new value network relationships can be created that support sustainable development (Hockerts & Wüstenhagen, 2010). That is, in Case #07, an MNC supported a much smaller company to further develop the smaller company's solution technically, so that it became more efficient, increasing its potential for application at scale. In this, the MNC supported the bid application, as well as made their network available to the smaller company.

With this, Case #07 overcame a barrier that also thwarted many projects at the third interview phase: a lack of support from relevant in- and external stakeholders. For instance, internal reorganisation and the addition of new projects to the innovation pipeline meant that the attention of one of the companies involved in Case #01 was directed elsewhere. Moreover, a lack of financial means, whether internal R&D budget or external funding to allow for further development or a commitment of a first customer, also proved prohibitive. This was so for Cases #01, #02, #03, #09, and #13f2, for example. In other cases, such as Cases #03 and #09, experienced scale as a prohibitive factor in continuing experimenting and developing the respective proposed solutions. That is, for pilots and experiments, economies of scale were absent that would have allowed them to acquire the needed resources for their solutions. Moreover, value chain risks (e.g., reliance on a single customer, suppliers going bankrupt, or experiencing long-term supply interruptions) were insufficiently factored in. In Case #09, for example, this proved a bottle neck for further development in 2016, which was not resolved until 2017 and the circular pivot rendering this no longer relevant.

A systematic approach to analysing stakeholder interests as well as potential strengths and weaknesses they could bring to the circular configuration could have aided the identification of incentives and directed effort towards creating further exploring how these could be captured for different stakeholders. Generally, it was not until the second round of data collection that the attention of the participants had

shifted from the (technical) development of the proposed solutions to considering stakeholders, whether in- or external to the focal company. Instead, designing value networks should be an integral part of COI.

## 5 | DISCUSSION: ACTION RECIPES FOR CE AND THEIR COHERENCE OVER TIME

Through the application of *action recipes* (Benford & Snow, 2000) for CE (Blomsma, 2018), we interrogated 23 cases of circular oriented innovation or COI, applying cross and within-case analysis. We identified four research questions, the first concerning *purpose*: What are the drivers behind engaging in COI? We have shown that the drivers consist of a complex mix of factors. Typically, the circular solutions aim to address multiple problems, among which prominently feature multiple structural wastes within each case. Moreover, there typically was the ambition to generate multiple benefits, such as improved profit margins for the customer, or easier installation or additional convenience for the user. Both problems and benefits were located across different places in the life cycle and were to be addressed as an integral part of the COI project. It can thus be said that a systemic perspective was applied to the *purpose* of the cases.

The second question concerned how the purpose is *elaborated* upon: How are circular strategies envisioned to address the perceived issues? It was shown that circular strategies function as part of *circular configurations*—situations where two or more circular strategies are present and interact through synergies, trade-offs and competition. In these configurations, synergies were actively sought and drawbacks consciously managed. The proposed solutions covered two or three resource states: Cases typically considered and examined circular strategies affecting materials, components and products. As such, there is a need to link knowledge and stakeholders when conducting COI in a manner not previously practised in the linear economy. That is, whilst scholarship into individual circular strategies such as industrial symbiosis, recycling and maintenance etc. is needed, for CE implementation, an understanding is needed of how these strategies function as a set.

An important implication of this is that, although there is a role for archetypes and typologies such as by Bocken et al. (2014) and Lüdeke-Freund et al. (2019) that highlight ‘pure’ types based on a single circular strategy, studying circular phenomena such as CBMs will have to start taking into account the complexity present in real-life cases. That is, a rigorous approach to understanding business processes for CE will have to consider the *circular configurations* that are present in COI. We have shown how the Circularity Compass, combined with the Big Five Structural Wastes, can serve as frameworks for this. As such, whilst much work on CE and COI has so far focussed on archetypes, our work calls for moving towards the study of circular configurations—as is in line with the question the CE umbrella puts before us.

Moreover, in addition to physical flows, information, energy and value flows are important in designing a fully functional circular metabolism, together with their infrastructure. Together, these aspects—resource, information, energy and value flows—make up the

part of CE oriented action recipes that describes solutions. Separately, the value, information and energy flows have been previously examined in relation to resource flows. See, for value flows, for example, Bocken et al. (2016) or Pieroni et al. (2019); for information flows, see Kristoffersen et al. (2020), the call for a European Dataspace for Smart Circular Applications and also company examples such as Madaster and Provenance; and see for energy flows Allwood et al. (2011), Cullen (2017), or Bakker et al. (2014).

The synthesis of these flows in a single framework is in line with other work that examines historical large-scale metabolism changes such as the impact on the Earth system of the evolution of photosynthesis or the establishment of agriculture (Christian, 2011; Lenton & Watson, 2011; Spier, 2015). When such large-scale metabolism changes happen, value, material, energy and information flows—together with the accompanying infrastructure and technology—change in an integral manner to allow for new flow patterns to emerge (Beinhocker, 2006; Lenton et al., 2016; Rifkin, 2011; Smil, 2017). This provides us with a theoretical and historical basis to position COI as aiming for a metabolism change in the economic system. The MLM model may provide an analytical framework for both theoretical and empirical work into understanding how the different layers are linked and how the whole can be designed such that it results in robust and equitable circular value chains, when complementary mapping methods for all layers are developed.

Third, we inquired into *proaction*: Who should (also) act to implement circular solutions? After the initial technical development, the attention shifted to value network dependencies. In many cases, this proved challenging: Many projects encountered difficulties progressing that stemmed from these value network dependencies. The difficulties encountered here signal that COI could run more smoothly if stakeholder interests as well as the potential strengths and weaknesses they could bring to the circular configuration were considered as an integral part of the COI process. But the question also arose about what the right time is to involve additional stakeholders. As Kraaijenhagen et al. (2016) also noted, involving certain stakeholders too early may preclude certain solution spaces, thus leading to sub-optimal solutions from a resource point of view. We therefore need to ask: When does early engagement lead to better outcomes? And when is it better to wait until the solution is more developed? When and under what conditions to involve which stakeholders—by proxy or through real engagement—are still an open question in COI on which further work is needed. Developments are underway to remedy the gap of structured methodology that exists with regard to value chain development (Blomsma et al., 2019; Konietzko et al., 2020), but these could be further strengthened by taking into account such questions.

It was shown that the *purpose-elaboration-proaction* steps are rendered sufficiently coherent for acting by omitting aspects of the problem situation earlier identified as important. This applied to nine cases in particular: Cases #01, #03, #06, #07, #09, #11b, #15i, #15j and #15k. In these cases, it was observed that projects focused on addressing one or more barriers seen as inhibiting the implementation of the envisioned circular strategies, whilst other barriers—although



discussed and seen as important—were subject to assumptions not further explored, or not addressed as part of the innovation process. As a result, no action was undertaken in these additional areas, so influence could not be exerted in locations in the value chain relevant to implementing the whole of the proposed solution.

For example, in Case #01, see also Figure 3—the infrastructure required for end-of-life processing was absent, whilst these strategies were a key component of the proposed solution. The interviewee acknowledged this but stated that developing this would be an issue to revisit in the future, once their solution would be used at scale. The substance cascade that forms one of the material inputs for this product was realisable in the short term, but the composting and semi closed-loop recycling were viewed as long-term objectives.

In meaning work terms, it seems that by focusing on one or more barriers, even if these constitute only a subset of the barriers that need to be overcome, action can be taken. The underlying reasoning seems to be that by taking away some barriers, more possibilities for future action are created. As such, the systemic outlook of many cases is not necessarily followed-up by systemic action—at least not in the first instance. This raises an important question: Do such partial actions or fuzzy solutions lead to systemic change in the long term? And, could it be a factor in the success or failure of COI also in the light of circular pivots? That is, if followed by a circular pivot, putting effort into detailing a solution too soon may represent wasted time and effort. Further work has to take up the question of when a circular solution can be called sufficiently developed before engaging in piloting and experimentation (Weissbrod & Bocken, 2017).

This notion of partial action is important for another reason, too. Although it has to be acknowledged that the initial funded parts of our cases lasted a mere 2–6 months (including extensions that were granted), which may have necessitated a narrow focus. However, all but one project showed potential at the second interview, with further actions planned. Therefore, another explanation may be offered: Cognitive processes aimed at avoiding cognitive overload undermined addressing systemic aspects. That is, complexity was purposefully omitted to prevent being overwhelmed.

This brings to the fore an important paradox. Systemic COI requires engaging with complexity. However, the expense of understanding the problem systemically is high compared to pragmatic local solutions (Scott, 2010). Moreover, many cognitive devices—also meaning work—are targeted at simplification. This simplification necessarily acts to reduce and redefine the problem and solution space, leading to a loss of clarity for the actual problem that should be solved. It should therefore be examined how future COI methodology should engage with and allow for appropriate engagement with complexity, including uncertainty. Further work needs to be done with regards to how to strike a balance: how to engage sufficiently deeply with complexity as to allow for transformative change, as well as how to not engage too deeply and get caught by ‘complexity paralysis’ (Bunnell, 1998).

Such work could involve linking with and drawing from other domains that have grappled with operationalizing complexity

science, such as transition science (e.g., Grin et al., 2010) or the domain of systemic design (e.g., Jones & Kijima, 2018; Pendleton-Jullian & Brown, 2018). Reinvigorating and further elaborating upon the sensemaking literature on complexity (e.g., Colville et al., 2012; Snowden & Boone, 2007) could also prove fruitful. The study of failure and restarts could be another important avenue to pursue as it could lead to a better understanding of what pitfalls to avoid or how to overcome them, as this study has shown that it is not uncommon for restarts to take place after many years. The duration and type of studies undertaken are therefore important factors in future work.

Lastly, we asked, given the dynamic nature of action recipes, how do action recipes for CE change over time? We have shown that meaning work both inhibits and enables change (Benford & Snow, 2000), also in the context of CE. At the third interview phase, many cases were ‘on hold’. Compared to the first phase, the action recipes were clarified somewhat, but few significant changes were made. In the fourth interview phase, cases had restarted again largely as a result of both traditional *pivots* (new target market for example, for example (Ries, 2011)) as well as *circular pivots*: a significant change in the type or role of circular strategies that changes the nature of the circular configuration. That is, it seems meaning had to be reexamined and reestablished for the projects to move forward again, which describes an unfreeze–refreeze dynamic (Schein, 1996).

However, participants generally lacked a structured approach to identifying relevant circular strategies. And they did not have deliberate steps in the process that allowed them to review and adjust their use of circular strategies through circular pivots, MVCC, continuous improvement and considering interactions between circular strategies. Our results show that when going from idea to action circular configurations are likely to evolve and change, especially if the proposed change requires a redesign rather than adaptations compared to current systems. This raises the question of under what circumstances circular configurations need to be reexamined to avoid developments from being held up or getting stuck. Further work as to where in business processes this could be supported could contribute to accelerating the adoption of CE practices as well as how this can best be accomplished.

This lack of application of structured approaches in practice—to complexity, to circular strategies and to value network development—may have contributed to the difficulties that were experienced in progressing the proposed solutions and risk resulting in incremental change or ‘muddling through’ (Lindblom, 1959). This risks that CE will not achieve its transformative potential (Bauwens et al., 2022; Clube & Tennant, 2020), and we therefore call for organisation scholarship that focuses on enabling systemic change through COI.

## 6 | CONCLUSION

The CE umbrella requires conceding that in particular the relationship *between* circular strategies is not yet well understood. Also, in need of clarification is how their application can lead to the rapid transition

from linear to circular industrial systems that is so urgently needed (Bauwens et al., 2022; Corvellec et al., 2020; Kirchherr & Santen, 2019). That is, whilst CE groups many circular strategies under its umbrella, these cannot be treated as interchangeable from the perspective of management and organisation science. Structural waste is presently hard for practitioners and academics alike to investigate, elucidate and innovate for, but these capabilities are urgently needed if management and organisation science are to meaningfully contribute to a rapid implementation of CE in businesses.

Since current circular strategy frameworks aimed at characterising or describing circular solutions are largely normative and conceptual, our resulting objective was twofold: (1) to develop an analytical framework that is grounded in both theory and practice, as well as (2) to demonstrate the application of such a framework to a wide range of different circular solutions and how this can lead to new insights and new directions for research. To this end, a longitudinal qualitative multi-case study design was used to investigate how COI projects move from idea to action, using *meaning work* and *action recipes* to inform the analytical framework and research design.

To achieve our first objective, we developed an analytical framework, action recipes for CE, which draws on the Resource States framework, and the related Circularity Compass and the Big Five Structural Wastes (Blomsma & Tennant, 2020), which was extended by further developing the Circularity Compass and adding the MFM or multi-flow model. This allowed us to successfully describe the physical reality that is the subject of the COI process.

Our second objective we achieved through application of the analytical framework and cross- and within-case analysis of the 23 cases. Already in the above many salient insights were highlighted, new questions identified and directions for further work discussed. Whilst the current dataset does not yet suffice for larger scale pattern finding, we have provided insight into how case mappings can be created that can serve to bring rigour to contributions to CE from management and organization science. That is, the proposed frameworks allows for contextualising *what is circular* about a case by elucidating: *why* circular strategies are seen as offering solutions, *what* (variations of) circular strategies are being examined, and *who* is envisioned to act the context is missing to position contributions.

With this, organisation science gains the capability to characterise or describe the physical realities being investigated. This unlocks pattern-finding capabilities irrespective of what organisation theory or framework is being used. When examining CBMs through the lens of, for example, the resource base view, transaction cost theory or risk, clearly identifying the role of, for instance, sufficiency, sharing or their application as a set, allows for a deeper understanding of contextual factors that stem from the presence of different circular strategies. Similarly, the presence of maintenance and/or remanufacturing can be correlated to, for example, the barriers and enablers these different circular strategies may encounter in value chain design, stakeholder management and the ability to attract finance, thus bringing much needed depth to insights on CE from operations management, stakeholder theory and sustainable finance, respectively.

In other words, the proposed analytical frameworks make a contribution to management and organization science more broadly by making it possible to position different contributions in relation to each other as well as to other work in the domain of CE from, for example, design science or sustainability science. That is, using the Compass clarity can be offered on, for example, whether recycling, reuse or a combination of these strategies play a role in a given situation, which allows for contextualising COI best practice taking the similarities and differences of these strategies into account. COI cases can now be compared constructively using different theoretical lenses.

In addition to this, we have identified new promising directions for CE research: how circular pivots aid in moving towards implementation and how minimal viable circular configurations or MVCCs can be chosen. We have also highlighted continuous improvement of circular configurations and interactions between circular strategies as particularly important phenomena that play an important role in implementing CE—and the importance of taking a longer time horizon to understand circular phenomena in business.

With the generated frameworks, we provide a foundation for further knowledge creation and development: A common starting point from which other work on CE, both theoretical and empirical, can depart. We believe that our analytical frameworks can be used alongside and in addition to other management and organisation theories and frameworks, to contextualise and deepen insights. In this sense, the generated frameworks have the ability to serve as ‘scaffolding’ for generating and synthesising knowledge across different scientific contributions.

We contend that CE cannot simply be regarded as ‘yet another’ application domain of organisation theories and approaches without engaging appropriately with the physical reality—and the possibilities and constraints that stem from it and that co-evolve with the organisational realities as innovation takes place. The physical reality and organisational reality are co-dependent and co-create each other, as explored by other scholars from the domain of socio-materiality such as Latour (1993, 2005) in his actor-network theory. Other scholars have also taken up this thread in the area of resource flows (e.g. Baumann & Lindkvist, 2021). We added to this by providing a set of frameworks that can be used to deepen insights generated from inquiries specific for COI, showing how good scholarship can appropriately characterise and describe *what is circular* about a situation.

We furthermore encourage inter- and transdisciplinary work to, for example, bring closer together innovation approaches from engineering and design science with management and organisation scholarship, as well as ensure such approaches find adoption in practice. Although such scholarship can take up more time, more can be learned from it, allowing for a deeper understanding of CE and thus—perhaps paradoxically—accelerating its implementation. That is, it may be beneficial to ‘slow down in order to speed up’—also with regard to the publication treadmill. With the central aim of creating well-functioning circular configurations, different disciplines can contribute to better understanding how to bring them about and how to do so more quickly. With this, we point the way forward for scholarship that engages with CE as a complex phenomenon.

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## ENDNOTES

- <sup>1</sup> This term is adopted to make explicit that our interpretation of 'waste' goes beyond the colloquial meaning of the word—usually limited to something thrown out or discarded. Here, we mean all types of waste resulting in neglecting to conserve resources, inefficient or harmful use of resources, and un- or underused productivity of resources.
- <sup>2</sup> A demonstration involves a passive but observant audience and an active performer whose task it is to convey (tacit) knowledge. In contrast, when the situation is regarded as a practice, active participation as well as reflection become key activities. If the situation is seen as an experiment, it revolves around the expected outcomes. Following procedure and monitoring conditions become key. In contrast with the practice situation, there is less tolerance for mistakes. In these examples, the exact same people can be involved, and the exact same tasks performed, but the meaning attributed to the situation is different.
- <sup>3</sup> Case #08 was split into case #08 m (original focal company) and #08n (participant continuing to pursue original ideas in new consortia).

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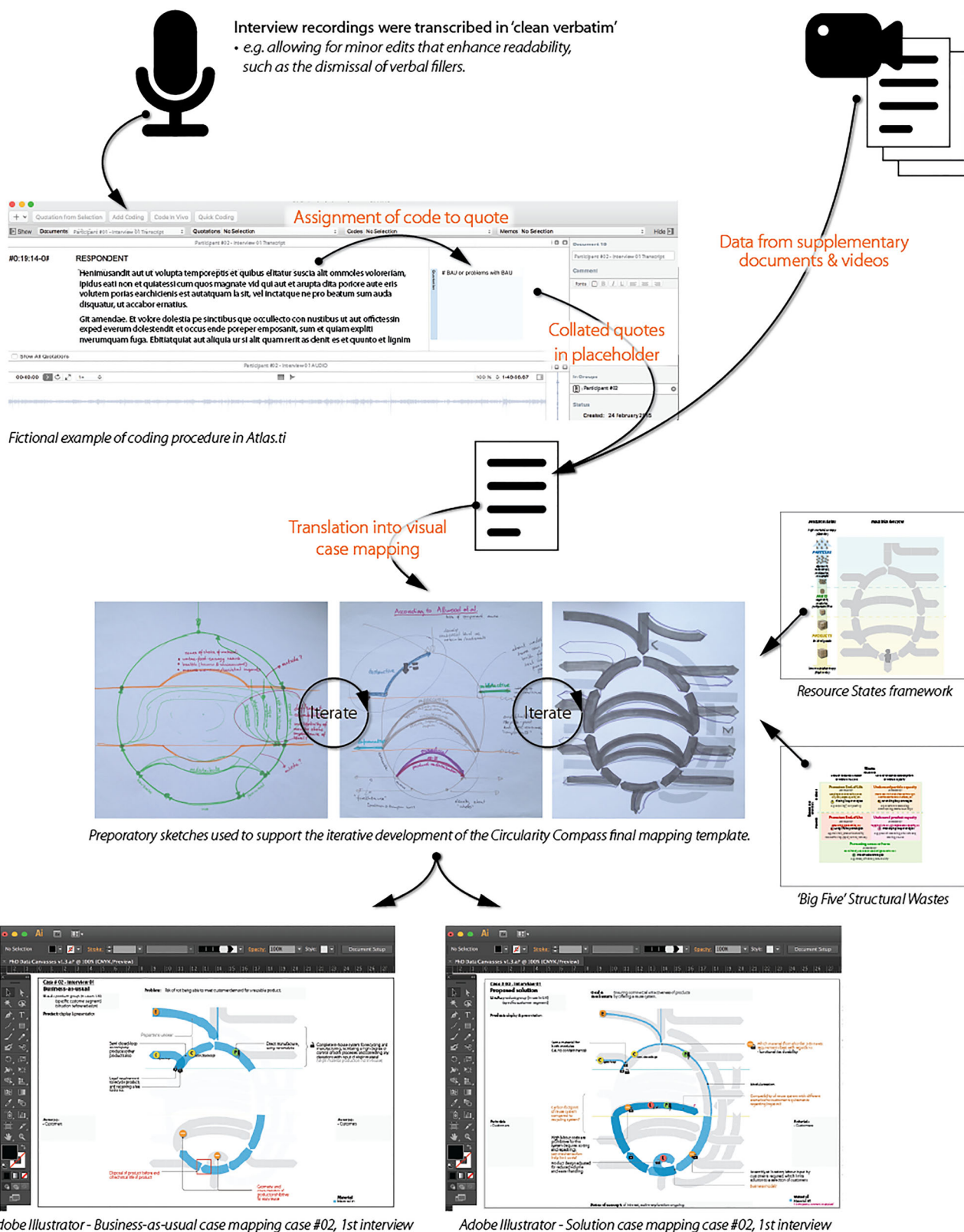
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## APPENDIX A: VISUAL REPRESENTATION OF THE APPROACH TO DATA COLLECTION, PROCESSING AND ANALYSIS



**FIGURE A1** Examples of a circular pivot. Continuation of Figure 4: Interview Phases 3 and 4 depicted here. For earlier phases, see Figure 4

## APPENDIX B: TABLE WITH OVERVIEW OF DATA COLLECTED PER PHASE OF THE RESEARCH

Table overview of the different classes of products, role of interviewees and the type of company in each phase

Classification of products				
	Interview phase 01	Interview phase 02	Interview phase 03	Interview phase 04
Electric	<b>6</b>	<b>7</b>	<b>5</b>	<b>1</b>
Case numbers	#06; #11a, b, c; #12c, e	#06; #11a, b, c; #12c, e #14 h	#06; #11a, b, c; #14h	#11a
Housing and living	<b>6</b>	<b>9</b>	<b>8</b>	<b>3</b>
Case numbers	#01; #04; #07; #12d; #13f1; #13f2	#01; #04; #07; #11d; #12d; #13f1; #13f2; #14g; #15j	#01; #04; #07; #11d; #13f1; #13f2; #14g; #15j	#01; #04; #07
Display & presentation	<b>2</b>	<b>5</b>	<b>4</b>	<b>2</b>
Case numbers	#02; #03	#02; #03; #15i, k, l1–4	#03; #15i, k, 1–4	#02; #03
Miscellaneous	<b>3</b>	<b>4</b>	<b>4</b>	<b>4</b>
Case numbers	#05; #08; #09	#05; #08, #09, #10	#05; #08, #09, #10	#05; #08, #09, #10
Total	<b>17</b> (15 discounting overlap)	<b>25</b> (23 discounting overlap)	<b>21</b> (no overlap present)	<b>10</b> (no overlap)
Classification of role interviewees				
Strategic management	<b>9</b>	<b>9</b>	<b>8</b>	<b>8</b>
Case numbers	#01; #02; #04; #05; #09; #11a; #11b; #13f1; #13f2	#01; #02; #04; #05; #09; #11a; #11b; #13f1; #13f2	#01; #04; #05; #09; #11a; #11b; #13f1; #13f2	#01, #02, #03, #04, #07, #08, #09, #11a
Engineer/manager	<b>6</b>	<b>7</b>	<b>4</b>	<b>1</b>
Case numbers	#03; #06; #07; #12c; #12d, #12e	#03; #06; #07; #10; #12c; #12d, #12e	#03; #06; #07; #10	#10
(design) consultant	<b>2</b>	<b>9</b>	<b>9</b>	<b>1</b>
Case numbers	#08; #11c	#08; #11c; #11d; #14g; #14h, #15i, #15j, #15 k; #15l	#08; #11c; #11d; #14g; #14h, #15i, #15j, #15k; #15l	#05
Total	<b>17</b>	<b>25</b>	<b>21</b>	<b>10</b>
Classification of focal companies				
Start-up	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>
Case numbers	#09; #13f1–2	#09; #13f1–2	#09; #13f1–2	#09, #11a, #08n
SME	<b>7</b>	<b>9</b>	<b>8</b>	<b>7</b>
Case numbers	#01, #02; #03, #04, #05, #08, #11a, b	#01, #02; #03, #03, #04, #05, #08, #11a, b, #14g	#01, #03, #03, #04, #05, #08, #11a, b, #14g	#01, #02, #03, #04, #05, #07, #08m
Large	<b>3</b>	<b>8</b>	<b>7</b>	<b>1</b>
Case numbers	#06; #07; #12	#06; #07; #12; #14h, #15i, #15j, #15k; #15l	#06; #07; #14h, #15i, #15j, #15k; #15l	#10
Total	<b>12</b>	<b>19</b>	<b>17</b>	<b>10</b>

Note: Numbers in bold indicate the total number of cases per phase; numbers preceded by ‘#’ indicate specific cases.



## APPENDIX C: OVERVIEW OF DATA AVAILABILITY PER CASE

