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Relational Frictions in Circular Economy Ecosystems: Designing for Transformative Futures

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ABSTRACT

In response to the growing tension between business growth and sustainable consumption, strategic design management offers frameworks to facilitate the transition from linear to circular models. This article examines the multifaceted challenges and opportunities companies face when engaging in circular economy (CE) ecosystems. Specifically, the article addresses the question: How does agency shape collaborative dynamics in the initiation and maintenance of partnerships within the global coffee value chain during socio-technical transitions towards circular practices? Through stakeholder interviews and follow-up conversations with decision-makers, our analysis highlights how relational frictions—emerging from the entangled dynamics of human–more-than-human systems—serve as both challenges and opportunities in navigating CE ecosystems. Our findings indicate that these frictions reveal the interconnected and context-dependent nature of collaborative practices, shaping both conflicts and transformations. We contextualize these findings within design and innovation management approaches, emphasizing the need for evolving participatory modes that enable transformative collaborations and foster circular futures.

Keywords: Circular Economy Ecosystems, Co-becoming, Human–More-than-human, Relational Frictions, Sociotechnical-Ecological Transformation, Strategic Design.

INTRODUCTION

Companies are increasingly encouraged to engage in genuine interorganizational collaboration that encompasses both human and more-than-human actors within their value chain ecosystems. Excluding certain actors diminishes the likelihood of fostering regenerative ecosystems, as every element within the system shapes the whole (Eisenreich, Füller, & Stuchtey, 2021; Pascucci, Alexander, Charnley, & Fishburn, 2023). Ignoring these interdependencies risks overlooking insights and opportunities arising from relationality (Raworth, 2017; Steffen, et al., 2018; Rockström, et al., 2009; Escobar, 2018).

To address these challenges, companies are urged to adopt collaborative, non-hierarchical ecosystem models (Chesbrough & Appleyard, 2007; West, Vanhaverbeke, & Chesbrough, 2006). Traditional business models, with siloed structures and short-term KPIs, are increasingly unsustainable in light of resource scarcity and climate change (De Angelis, 2018; Mostaghel & Chirumalla, 2021; CGR, 2021; Das & Bocken, 2024). This narrow focus perpetuates current practices and impedes long-term viability. As Escobar (2018) emphasizes, the complexity of interdependent systems cannot be grasped by isolating single

elements. A holistic understanding is crucial to transitioning value chains toward sustainability (Irwin, Kossoff, & Tonkinwise, 2015).

The linear coffee supply chain increasingly depletes the people, climates, and environments it relies on. Thus, climate change is expected to reduce suitable areas for growing coffee by up to 50% by 2050 (Grüter, Trachsel, Laube, & Jaisli, 2022), raising questions about coffee's future as a viable business. This study explores these questions through a collaboration with Danish coffee company Peter Larsen Kaffe, part of the Löfbergs consortium, which is moving toward circularity but has not yet achieved a fully circular value chain. Thus, this case study explores how design can navigate relational interorganizational change processes in the context of circular economy ecosystems. Throughout this paper, we use the term circular economy ecosystems (CE ecosystems) to describe multi-actor systems engaged in transitions from linear to circular practices, drawing on ecosystem thinking from both sustainability and innovation studies.

First, the article outlines recent studies on circular value chain transitions and highlights the importance of understanding how networks of stakeholders evolve into CE ecosystems. We adopt a relational perspective on socio-technical transformations, focusing on co-becoming, where actors iteratively adapt and evolve through mutual engagement, shaping shared futures (Manzini, 2015; Peschl, 2019). This iterative engagement, driven by collaboration and adaptive responses to challenges, is crucial for realizing regenerative systems.

Second, we present the research approach, including an analytical exercise using situational maps (Clarke, 2005), which guides the exploration of relational dynamics in the case study. The analysis uncovers and discusses the frictions identified in the study, followed by a discussion on frictions as an alternative to traditional drivers and barriers, visualizing interrelationships to foster deeper strategic thinking, and the coexistence of linear value chains and CE ecosystems.

Finally, we highlight the role of design in facilitating value chain transitions toward CE ecosystems, offering insights for organizations seeking to foster innovation and develop effective strategies for sustainability.

1. APPROACHING CIRCULAR ECONOMIES THROUGH ECOSYSTEMS

The tension between pursuing business prosperity and adopting sustainable consumption practices poses a pressing challenge if we aim to balance planetary boundaries and tackle issues like climate change and biodiversity loss for a viable future (Raworth, 2017; Rockström, et al., 2009). Although many profit-driven businesses may not initially experience negative impacts, their focus on short-term prosperity contributes to an imbalance that, over time, produces unforeseen societal and global consequences (Jones, 2014). With multiple planetary boundaries already crossed and inequality on the rise in most countries (United Nations), companies must prioritize more than profit and recognize their value chains as parts of broader, interconnected systems. This shift is critical to aligning business resilience with planetary health (Escobar, 2018; Raworth, 2017; Rockström, et al., 2009).

To navigate this landscape, it is essential for businesses to recognize how value chains fit into what we frame as broader sociotechnical-ecological systems, where every action is both influenced by and influences the interconnected environment. This article focuses on the

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current boundaries of linear value chains and their operations within a landscape of evolving roles. It explores how sellers and buyers relate, particularly through new types of resources, recovered relatedness, and rediscovered values in everyday practices (Irwin, Tonkinwise, & Kossoff, 2022). As value chains evolve, businesses are called to rethink their internal practices and their interaction with external systems. In order to facilitate less resource-demanding ways of conducting business, it is necessary for businesses to acknowledge entanglement and build stronger, more collaborative collectives. Most importantly, businesses are encouraged to develop partnerships that intertwine incumbent systems—systems that co-evolve and reshape based on new knowledge and ways of being (Irwin T. , Kossoff, Tonkinwise, & Scuppelli, 2015; Escobar, 2018). In this way, businesses are not seen as isolated entities but as part of a larger ecosystem, where actions are influenced by, and contribute to, the interconnected, evolving systems they are embedded in.

We consider this process a socio-technical transformation involving diverse stakeholders in tackling complex, "wicked" problems (Aarikka-Stenroos, Ritala, & Thomas, 2021; Geels & Kemp, 2007; Rittel & Webber, 1973), which contain contradictory information and stakeholder values within a fragmented network (Buchanan, 1992). Irwin et al. characterize this complexity as interwoven dynamics of everyday life, spanning multiple scales (Irwin, Tonkinwise, & Kossoff, 2022) and the disconnection they describe reveals the need for approaches that acknowledge the interdependence and relational dynamics within ecological, social, and economic systems, as well as the co-evolution required in a post-Anthropocene epoch (Lehmann, 2023).

The process of paving the way for a CE ecosystem to emerge and evolve requires companies, decision-makers, and other actors to learn to engage in, explore, and navigate complex, interdependent stakeholder relationships (Aarikka-Stenroos & Ritala, 2017; Adner, 2017; Aarikka-Stenroos, Ritala, & Thomas, 2021; Heikkinen, Kujala, & Blomberg, 2023; Kaipainen, et al., 2023). This process, however, demands not only the ability to understand and map these interrelations but also the practical wisdom to navigate them effectively. As Flyvbjerg argues, practical wisdom involves the ability to make judgements in complex situations where decisions are often ambiguous and uncertain, guided by experience rather than strict rules (Flyvbjerg B. , 2001). Previous studies demonstrate the complexity and expansive nature of stakeholder interdependency (Adner, 2017, p. 55), and thus, for companies, the ability to adapt and respond wisely in these situations is crucial.

Peter Larsen Kaffe has taken steps to establish a community, Circular Coffee Community, of diverse stakeholders around their collaborative, innovative initiatives and value propositions. As 'business as usual' proceeds for both Löfbergs and Peter Larsen Kaffe, alongside their initiatives under what they call the 'Era of We'—an initiative aimed at fostering collaborative stakeholder engagement for sustainable innovation—we, the authors, view these initiatives as experiments. Specifically, we see them as experimental opportunities to learn how a company's engagement with diverse stakeholders can emerge and evolve when aiming "to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations" (Kirchherr, Reike, & Hekkert, 2017, p. 229). These complex interrelations underscore the transformation necessary for a circular economy, where interdependence and relational awareness foster 19sustainable pathways in interorganizational collaborations.

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As explained above, various stakeholders in the circular economy (CE) ecosystem engage in complex and often interdependent relationships, where both opportunities and challenges arise. These opportunities and challenges are often seen as drivers and barriers (Bocken, De Pauw, Bakker, & Van Der Grinten, 2016; Ranta & Mäkinen, 2018). Two main reasons explain why these dynamics occur: (1) it is difficult to decide who should primarily drive change—whether it is the consumer, the company, or the politicians, and (2) engaging stakeholders across the diverse CE ecosystem simultaneously presents a challenge. In this research, we define drivers and barriers as follows (inspired by Tan, Tan, & Ramakrishna, 2022, p. 2):

- Drivers: Factors that have a positive influence on the emergence and evolution of the Circular Coffee Community ecosystem, including those of a motivating, supporting, enabling, or accelerating character.
- Barriers: Factors that have a negative influence on the emergence and evolution of the Circular Coffee Community ecosystem, including those of a hindering, constraining, challenging, or restricting character.

In this paper, we contribute to the literature by examining how drivers and barriers manifest in a company's ecosystem strategy, using a case study of Peter Larsen Kaffe. This case shows how these dynamics influence the company's efforts to 'circularize' its value chains and engage stakeholders in transformative collaborations, a key step in advancing the CE agenda. Drawing on Flyvbjerg's work on practical wisdom, which emphasizes the importance of context, experience, and practical judgment in navigating complex situations (Flyvbjerg, 2011), we argue that understanding these dynamics is essential for companies navigating interdependencies within their CE strategies.

Several scholars have highlighted the lack of knowledge on how ecosystems emerge and evolve (Aarikka-Stenroos, Ritala, & Thomas, 2021; Heikkinen, Kujala, & Blomberg, 2023; Kaipainen, et al., 2023). A key factor in understanding these dynamics is the agency of actors. Aarikka-Stenroos et al. (2021, pp. 272-273) argue that "the agency of actors is fundamentally enabled and constrained by both the specificity of the underlying assets of each actor and the institutional environment." This suggests that how actors navigate relationally depends on their resources and the broader institutional context.

In this paper, we examine how the agency of actors in the CE ecosystem affects their ability to collaborate and innovate despite the drivers and barriers they face. By focusing on relations and agency, we aim to provide insights into how actors can navigate the challenges of building and sustaining circular economy ecosystems.

2. RESEARCH METHODOLOGY

In this qualitative design case study, we explore how collaborative partnerships are initiated and sustained within the context of socio-technical transitions to circular practices in the coffee industry. The study focuses on Peter Larsen Kaffe's transition to circularity, examining how agency shapes collaborative dynamics and why design plays a key role. This research goes beyond observation to understand how organizational practices and relationships are actively influenced by design decisions.

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2.1. Semistructured interviews and follow-up

The semistructured interviews with Peter Larsen Kaffe and Löfbergs employees occurred as Peter Larsen Kaffe was actively establishing interorganizational collaboration to achieve circularity in its coffee value chain. Thus, employees provided insights into company practices, strategies, and potential drivers of and barriers to Circular Coffee Community. These perspectives were informed by the various Peter Larsen Kaffe departments which were concurrently engaged in regular business activities and were selected in dialogue with representatives from the innovation and marketing departments, with the aim of covering key aspects of the company's value chain. The two departments under Operations, Micro Roastery Production and Technicians & Service, were not intentionally excluded, but rather represent areas that could naturally have been included in a subsequent interview cycle. Their absence reflects a practical limitation of the study, not a deliberate methodological choice. One stakeholder from Löfbergs offered a broader global perspective, complementing Peter Larsen Kaffe's primarily Danish focus.

The semistructured interviews, follow-up conversations, and official documents provided an inside-out exploration of the emerging ecosystem from the perspective of the keystone company's value chain, which was appropriate at this nascent stage of ecosystem development for an individual company. To ensure the clarity and relevance of insights presented in this paper, we streamlined the use of direct citations by omitting repetitive wording and condensing less essential passages. This approach maintains the qualitative richness of the statements while focusing on its relevance to the relational dynamics shaping interorganizational collaborations.

While the scope of participants offered valuable insights into the early formation of the CE ecosystem, future research could include additional departments and external stakeholders to further illuminate the interdependencies and frictions shaping circular economy transitions.

Table 1: Three types of methods to obtain knowledge about the situational specificities of Peter Larsen Kaffe, Löfbergs, and the Circular Coffee Community.

Methods	Participants / Activities / Source References
Semi-structured interviews with employees. Conducted to clarify situational interrelationships between key elements, dilemmas, interests, and viewpoints, with interviewees representing ongoing linear business operations.	Six interviews with eight employees. Between March 23 to May 3, 2023. (Peter Larsen Kaffe) Community Coordinator, Marketing Event Manager, Marketing Controller, Finance Senior Consultant, Out-of-home Two Key Account Managers and Head of Retail (Löfbergs) Head of Marketing
Follow-up conversations with the decision-maker. Followed up on initial insights to explore resonance with their perspectives, highlighting aspirations toward building a transformative CE ecosystem.	Online meeting, Chief Innovation Officer (CIO), August 22, 2023 (early findings) In person meeting, CIO and external partner, September 12–13, 2023 (initial analysis) Online meeting, CIO, October 26, 2023 (ecosystem progress)
Desktop research Comprised retrospective reflections and future visions of the company.	Official company reports (see references) and company documents such as organizational chart, newsletters, event invites, and videos from YouTube channel (see materials list).

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2.2. Using situational maps as an "analytical exercise"

Using situational analysis (Clarke, A. E., 2003; Clarke, 2005), we map relational frictions, drivers, and barriers in the circular economy ecosystem, aiming to guide transformation. As Clarke (2005) suggests, this approach reveals the interdependencies, power structures, and histories that are essential for understanding and shaping transitions in Peter Larsen Kaffe's value chain.

Given the empirical nature of the case study, we employed Adele Clarke's situational maps as an analytical tool to visualize and analyze the relational dynamics within the emerging CE ecosystem. Situational maps help map out the key human, more-than-human, discursive, and other elements, revealing the complex relations among them (Clarke, A. E., 2003). This approach illuminated how drivers for some actors acted as barriers for others, revealing frictions that both hindered progress and highlighted where radical change was needed to align with the shared Circular Coffee Community vision. Additionally, the analysis exposed gaps in representation, identifying stakeholders whose absence limited collective agency.

Nold (2023) further emphasizes the relational approach as a means to explore the multi-layered, multi-sited dynamics of situations, while Clarke highlights how this approach captures the entangled relations of discourse, agency, action, and context (Clarke, A. E., 2003). In the case of Peter Larsen Kaffe, the complexity of the socio-technical environment, with its diverse stakeholders and evolving interactions, required an analytical lens capable of illuminating these otherwise invisible interrelations. By applying situational maps, we were able to unpack the hidden dynamics within this transition toward a circular economy, offering insights into the broader shifts at play and the role of various actors within them. Thus, when taking the next step in the analysis—the relational analysis with situational maps (Clarke, 2005)—we chose to create one map focusing on the Circular Coffee Community and related drivers and another focusing on the Circular Coffee Community and related barriers.

3. ANALYSIS IN RELATION TO VALUE CHAINS

To understand how circular economy principles take shape within a real-world setting, this section analyses Peter Larsen Kaffe's efforts—together with the Circular Coffee Community—to foster a circular ecosystem. By examining perspectives from production, processing, and consumption, we uncover how the company mobilizes dialogue, collaboration, and innovation in pursuit of its 2030 goal of zero waste and circularity. At the same time, the company's 2021/2022 report highlights critical challenges, including global competition, resource constraints, and heightened sustainability demands (Peter Larsen Kaffe Management & KPMG, 2022).

3.1. Main factors and an overview of the present value chain

The interviews revealed differing perspectives across departments on Circular Coffee Community's purpose and goals. Marketing emphasized fostering collaboration and systemic change, while other departments focused more on resource efficiency or market differentiation. For instance, the event manager described Circular Coffee Community as a dynamic community of experts sharing knowledge and resources (personal communication, March 15, 2023), whereas the financial controller highlighted practical goals, such as better coffee plant utilization (personal communication, May 3, 2023). These differences illustrate the challenge of balancing visionary ambitions with operational realities.

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Peter Larsen Kaffe categorizes Circular Coffee Community partners into innovation, market access, knowledge, and value chain partners, reflecting an effort to engage diverse actors in circular business models. However, competitive tensions hinder full collaboration. As the community coordinator noted, inviting competitors into the Circular Coffee Community remains a sensitive issue, even though it aligns with the systemic goals of circularity (personal communication, March 15, 2023).

Despite Circular Coffee Community's ambitions, critical gaps in representation remain. The focus on consumer-facing initiatives, such as reusing spent coffee grounds, overshadows upstream issues like farming and agroforestry. Furthermore, more-than-human stakeholders—such as soil, water, and biodiversity—are often absent from discussions, creating "sites of silence" that impede systemic progress (Clarke, 2003, p. 561).

Circular Coffee Community demonstrates innovative circularity efforts but also highlights the difficulty of aligning diverse stakeholder needs and addressing systemic gaps. By broadening its focus to include upstream value chain elements and more-than-human actors, Circular Coffee Community could enhance its potential as a model for regenerative ecosystems.

3.2. Active ecosystem building: consumer practices

The brewing of coffee, central to its consumption, leaves behind spent coffee grounds, with less than 1% of the bean utilized in the process (Peter Larsen Kaffe & Löfbergs, 2022). This generates approximately 60 million tons of waste globally each year, despite the grounds being rich in biomaterials like nutrients, cellulose, and oils (Forcina, Petrillo, Travaglioni, Chiara, & Felice, 2023). While these materials hold significant potential for reuse, most end up discarded.

Circular Coffee Community initiatives have explored ways to reclaim coffee waste by creating diverse products—ranging from cocktails to car doors, pens, furniture, mushroom cultivation, creams, and soaps. Yet scaling these efforts reveals systemic challenges. As the Out of Home senior consultant noted, "It's not the portfolio we're missing. It's everything in between..." (personal communication, March 15, 2023). This refers to logistical gaps and a lack of cohesive systems for collecting and processing spent coffee grounds efficiently.

Consumer engagement also presents a major barrier. The head of retail highlighted the challenge: "How does that make sense for Mrs. Jensen, who buys a bag of coffee?" (personal communication, April 25, 2023). This question underscores the difficulty of connecting large-scale sustainability initiatives with consumers' daily lives, where tangible incentives are often needed for participation.

While Circular Coffee Community efforts to upcycle spent coffee grounds into high-value products, such as food-grade materials, have reduced waste, they fall short of broader circular economy (CE) aims. CE aims not just to minimize waste but to restore ecosystems (Ellen MacArthur Foundation, 2023a). Current initiatives do not address upstream conditions, such as those faced by coffee farmers or the long-term viability of coffee production.

Achieving systemic impact requires stronger collaboration across the value chain and infrastructure to support consumer participation. Without these efforts to scale, CE practices risk remaining fragmented and disconnected from the deeper transformations needed to ensure sustainable futures for all stakeholders.

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3.3. Hesitant ecosystem building: Farming practices

Revisiting the heuristic visualization, we added more-than-human stakeholders to the farming phase before coffee cherries are harvested (see Figure 1). During the situational analysis, critical more-than-human elements were largely absent from discussions. These "sites of silence" (Clarke, A. E., 2003, p. 561) may be key to advancing a regenerative circular economy. For instance, farmland is often assessed by hectares rather than soil quality or its role in local ecosystems (Marbun, Nasution, Hanum, & Karim, 2019).

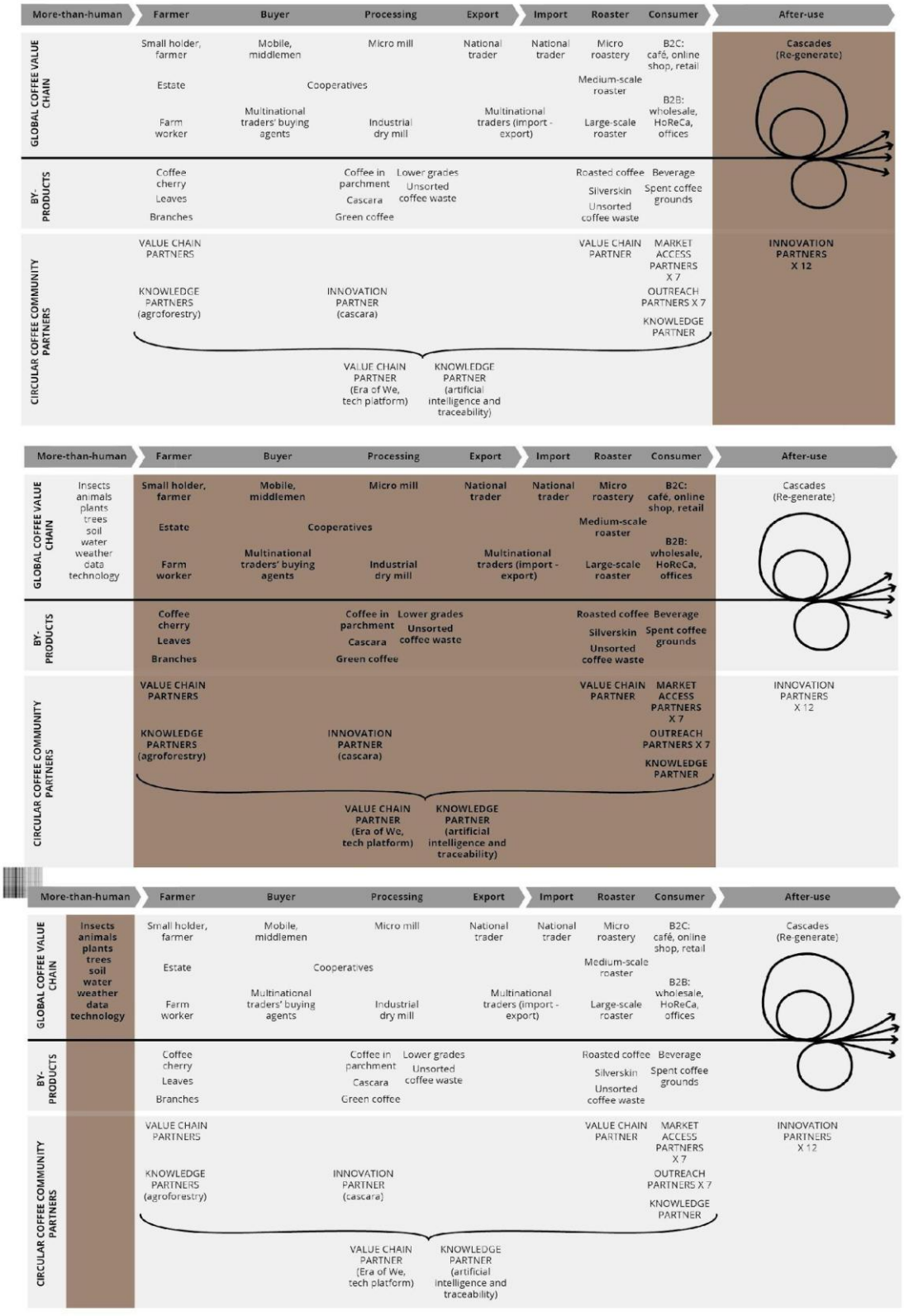

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Figure 1. Heuristic visualization of value chain and ecosystem interactions. This diagram serves as a generative tool to explore systemic relations and circular cascades across different stakeholder groups, including more-than-human actors.

A stakeholder mapping session with Peter Larsen Kaffe's innovation team—held shortly before their transition into the spin-off GrowGrounds—served to surface previously overlooked stakeholder groups, including more-than-human actors. This intervention revealed critical gaps in the case owners' perspective and led to the addition of a category for more-than-human stakeholders. Reflecting on this, Peter Larsen Kaffe's CIO remarked, "That is essentially what it is all about" (personal communication, September 13, 2023).

The Ellen MacArthur Foundation (2022) cautions that failing to return nutrients to soil depletes its health and increases reliance on chemical fertilizers. Yet, in interviews, soil health and regenerative farming practices were not mentioned. Instead, the focus was on the Peter Larsen Kaffe platform 'Era of We', which aims to bypass middlemen and improve farmers' economic conditions. Climate challenges were acknowledged, with the Out of Home senior consultant highlighting the need for more robust coffee plants: "If we could make a different type of coffee plant…" (personal communication, March 15, 2023).

These findings reveal a dominant human-centered perspective, often reducing circular economy challenges to human willingness or motivation. However, as Latour reminds us, "things strike back," emphasizing the necessity of considering human–more-than-human (dis)entanglements (Latour, 2000). Advancing regenerative practices therefore calls for tailored approaches that address the unique dynamics of each value chain—underscoring the importance of deeper sector-specific investigations.

3.4. Controversial ecosystem building: Organizational practices

When innovation aimed at radical socio-technical change intersects with communication strategies targeting consumers, the collaborative community's focus becomes unclear. This case illustrates a fundamental debate: should companies push for circular economy transitions or wait for consumer demand to pull? In this instance, the innovation department drives change, highlighting urgent issues like coffee farmers' poverty and environmental threats. However, their outreach targets innovation partners focused mainly on consumer behavior, which perpetuates the push-or-pull dynamic that seems to hinder more proactive, co-creative transformations.

Retail's primary concern is ensuring financial compensation for farmers, but their approach reflects a more immediate focus on the next customer, rather than long-term transformation. The problem arises when financial incentives and stakeholder demands across the value chain collide. As one Retail interviewee explained, the complexities of the stock exchange and trading systems often prevent profits from reaching farmers (Head of Retail, personal communication, April 25, 2023). This highlights the challenge of bridging gaps within the value chain and underscores the need for a holistic approach, addressing all stakeholders—not just the end consumer.

Additionally, communicating complex, radical transformations to consumers remains a challenge. Retail employees are concerned about high customer expectations but recognize the potential for future shifts, driven by science-based targets and new product offerings. Despite this, introducing circular products or sustainable practices is slow, as innovations in consumer behavior and expectations lag behind. Nevertheless, shifts like those seen during the COVID-19 pandemic—such as the rise in at-home brewing—suggest there is potential for change, when everything is turned upside down at the same time and when new possibilities emerge, challenging the traditional push-or-pull dynamics.

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Having analyzed the empirical findings from production, processing, and consumption perspectives related to the circular economy value proposition, it is clear that organizational practices and interdepartmental dynamics play a crucial role in shaping the trajectory of transformation. The next section will explore the implications of these findings for decision-making processes, particularly how they impact circularity within the coffee value chain. We will also discuss how design and innovation management fields can provide guidance on navigating this complex transformation, ultimately offering pathways forward for both practitioners and scholars.

4. DISCUSSION

The findings illustrate that navigating circular economy (CE) ecosystems is not a linear progression from barriers to drivers but a far more entangled process. The frictions observed across production, processing, and consumption stages suggest that existing managerial and design frameworks struggle to capture the relational and adaptive nature of circular transitions. Rather than seeing challenges as isolated obstacles, we argue that transformation in CE ecosystems emerges through ongoing frictions—negotiations, misalignments, and reconfigurations that shape both collaboration and resistance.

To advance design and innovation management approaches within these evolving ecosystems, we propose three key shifts: (1) replacing the contrast between drivers and barriers with a friction-based perspective, (2) integrating relational mappings of human and more-than-human actors to illuminate hidden interdependencies, and (3) recognizing the interwoven development of company-specific value chains and broader CE ecosystems. Achieving meaningful transformation in this space requires more than overcoming obstacles—it calls for an approach that fosters 'co-becoming,' where actors adapt and evolve through mutual shaping and collaboration (Manzini, 2015; Peschl, 2019; Haraway, 2016).

4.1. Drivers and barriers

Although we agree that “identifying and comparing the drivers of and barriers to CE implementation would benefit the acceleration of the development path” (Ranta & Mäkinen, 2018, p. 1), we propose that the term frictions might offer a more insightful perspective. Friction offers a lens to understand the dynamics of interconnected economic systems, highlighting the tensions that often drive transformation (Tsing, 2005). Rather than categorizing elements as purely drivers or barriers, friction reveals their interconnected and context-dependent nature, where what enables progress in one area may act as a barrier elsewhere (Tsing, 2005). This perspective underscores the complex interdependencies and interactions within the system, emphasizing the relational complexities shaping change. Our findings indicate that 'friction' more accurately encapsulates these relational complexities, where differing perspectives, values, or practices interact to generate frictions that drive both conflict and collaboration, reshaping socio-technical landscapes (Tsing, 2005; Drazin, Knowles, Bredenbröker, & Bloch, 2020).

The concept of 'co-becoming' enriches this perspective by emphasizing iterative processes through which actors—human and more-than-human—co-evolve, forming new relational patterns (Manzini, 2015; Peschl, 2019). Friction thus becomes a productive force, revealing alternative pathways and emergent forms of collaboration, while making visible the diverse

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values, knowledge, and power dynamics embedded in CE transitions (Bennett, 2010; Kjærsgaard & Boer, 2020).

4.2. Relational landscape maps

Relational mapping emerged as a critical heuristic tool for addressing the complexity of CE ecosystem transitions. By visually representing connections among actors, activities, and resources, these heuristic maps help identify friction points and untangle barriers to circularity. Offering a simplified but generative way to engage with complexity of value chains and ecosystem interactions, they enable companies to explore how linear and circular models interact, illustrating overlooked dynamics in value chains. Beyond visualization, relational maps serve as strategic tools, fostering deeper engagement with stakeholders. They allow for iterative re-assessments of how systems evolve, encouraging reflexivity and adaptability in decision-making processes—a capacity increasingly recognized as vital in democratic and design-oriented transitions (Vink, 2022). Such reflexivity supports the relational perspective underpinning co-becoming, helping to surface previously hidden interdependencies.

4.3. Co-existing of company value chains and eco-systems?

Balancing linear value chains with CE ecosystems presents a strategic dilemma: how to integrate sustainability ambitions without undermining profitability. The coexistence of these models highlights persistent frictions between current market dynamics and long-term regenerative aims. This tension calls for a rethinking of traditional business strategies, shifting towards ecosystem-based innovation. Such navigating involves a broader perspective, where companies adopt more adaptive strategies to align linear value chains with circular ecosystem priorities. Effective navigation hinges on the ability to manage relational frictions, using them as opportunities to explore new partnerships, align stakeholder objectives, and co-create regenerative futures. To support future applications, the following summary outlines key strategies for managing frictions and advancing regenerative change within evolving CE ecosystems:

- Frictions: Open up possibilities for sociotechnical-ecological transformation by making visible and reshaping entangled relations between human and more-than-human actors through collaborative exploration.
- Relational landscape mapping: Use heuristic visualizations to reveal hidden interdependencies and support more strategic and adaptive navigation of complex CE ecosystems.
- Co-existence of value chains and CE ecosystems: Call for rethinking traditional business models by balancing sustainability and profitability through integration of regenerative principles and future-oriented ecosystem perspectives.

4.4. Implications for design and innovation management approaches

To foster circular transformation, design and innovation management could benefit from shifting focus from isolated products or processes toward a broader, systemic involvement with a variety of stakeholders. As outlined in the 'Era of We', innovation should emphasize step-by-step involvement, starting with close partners and progressively broadening the network. This approach, grounded in open innovation frameworks (West, Vanhaverbeke, &

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Chesbrough, 2006; Chesbrough & Appleyard, 2007), acknowledges the need for flexible, evolving relationships.

However, navigating this transition requires more than technological innovation; it demands an ability to engage with the frictions and interdependencies that characterize CE ecosystems. Design practices offer tools to facilitate this process, enabling businesses to better align their strategies with the evolving demands of circular practices. By integrating co-design approaches and fostering collaborative, adaptive strategies, organizations can develop more resilient and regenerative business models. The transition from a linear to a circular economy thus invites companies to adopt an open innovation approach—one that emphasizes collaboration, mutual learning, and iterative development. This reflects the core of co-becoming, where transformation arises from dynamic and relational engagements between human and more-than-human actors.

5. CONCLUSION

The transition towards circular economy ecosystems presents both urgent challenges and transformative potential. As industries and organizations attempt to shift from linear models to regenerative, circular approaches, they encounter deeply embedded structural, organizational, and cultural frictions. While these frictions can be perceived as barriers, they also offer critical opportunities for innovation and systemic change. Addressing these complexities requires moving beyond isolated interventions towards an integrated, relational understanding of transformation—one that embraces interdependencies between human and more-than-human actors, as well as between companies and broader ecosystems.

This paper advocates for an extended systemic and relational approach to interorganizational collaboration in evolving CE ecosystems. By "extended," we refer to the need for a holistic stakeholder engagement, incorporating both human and more-than-human elements, to support transformations that move beyond human-centered designs. Using the agro-food case of a coffee company within the global coffee value chain, this study demonstrates the importance of addressing the perspectives of actors at all stages of the value chain to enable regenerative systems.

Siloed approaches and a focus on short-term goals were significant barriers, preventing company members from fully embracing a broader, systemic business perspective. Despite aspirations for sustainable practices, the focus on near-term customer needs and immediate market dynamics restricted the capacity for anticipatory, long-term innovation. Moreover, when one dimension—such as business interests—dominates over others, the balance and reciprocity necessary for ecosystem dynamics can be compromised. This limits the emergence of collaborative synergies, shared ownership, and mutual learning, which are key for enabling regenerative transitions.

The linear value chain remains underexplored, especially regarding its potential for transformation. In this case, innovation at the production stage showed promise for "doing more good," such as regenerating nature, while consumption-focused innovations tended toward "doing less bad," failing to initiate systemic changes. Both perspectives, however, underscore the need for comprehensive ecosystem-wide shifts that challenge hierarchies and redistribute agency.

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While Peter Larsen Kaffe in practice primarily approached circularity as a socio-technical challenge, this study reveals the need to understand such transitions as fundamentally socio-technical-ecological. Although the company's vision aimed to secure the long-term viability of the coffee industry and improve farmers' livelihoods (implicitly addressing ecological concerns) the operational scope of their circularity efforts focused mainly on partners related to the latter stages of the value chain. The relational dynamics uncovered in interviews and heuristic visualizations exposed how ecological entanglements, such as climate vulnerability and resource regeneration, are inseparable from organisational and technological concerns. This aligns with Ceschin and Gaziulusoy's (2019) Design for Sustainability framework, which emphasizes the importance of addressing sustainability challenges at the socio-technical-ecological system level, through earth-centric and complex systemic innovation. Acknowledging these dimensions is essential for enabling truly systemic and regenerative change.

This study also highlighted the challenges of engaging external stakeholders in co-creating circular futures. While external perspectives can inspire innovation, they often feel disconnected from the immediate concerns of those embedded in the value chain. Tools like heuristic relational visualizations help untangle complexities and foster deeper discussions, supporting broader systemic thinking.

The slow progress of CE ecosystem implementation in established companies points to the need for more sector-specific studies to explore barriers, frictions, and actor dynamics. Frictions, in particular, serve as catalysts for reflection and transformation by revealing underlying tensions and opening pathways for change. Navigating these frictions involves fostering deeper collaborations and aligning diverse stakeholder perspectives to support broader systemic thinking and co-create circular futures.

While the scope of participants offered valuable insights into the early formation of the CE ecosystem, future research could include additional departments and external stakeholders to further illuminate the interdependencies and frictions shaping circular economy transitions.

Finally, this study emphasizes the importance of adaptive step-by-step approaches that foster co-becoming and gradual transformation. Building strong stakeholder engagement and ensuring equal participation across value chain hierarchies are crucial for achieving regenerative and circular ecosystems that balance environmental, social, and economic priorities.

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ENDNOTES

We refer to this visualization as a heuristic to underscore its function as a generative tool for discussion and reflection rather than a comprehensive or definitive representation. As such, it serves to simplify and make accessible complex system interactions while remaining open to contextual interpretation and iterative refinement.

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APPENDIX

Appendix A: Materials List

(The following materials were reviewed as part of the situational analysis and background research.)

Reports:

- Peter Larsen Kaffe Statusrapport 2022 & Löfbergs Sustainability Report 2021/2022, Löfbergs, 2022
- Peter Larsen Kaffe Management & KPMG, årsrapport, Peter Larsen Kaffe, Viborg, 2022

Documents for website:

Peter Larsen Kaffehttps://www.mynewsdesk.com/dk/peter-larsen-kaffe/pressreleases/nu-kan-du-spise-dit-kaffegrums-hos-7-eleven-3251850, may 23.

Websites:

- Circular Coffee Community, Löfbergs Group, https://circularcoffeecommunity.com, march 2024.

PLK documents

- Organisational chart.pptx
- Organisation_PLK_CCC_marts2023.doc

CCC newsletters from:

- May 2022,
- June 2022
- September 2022
- November 2022

CCC event invites from:

- April 2022
- June 2022
- August 2022

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CCC YouTube Channel:

- Circular Coffee Community, https://www.youtube.com/@circularcoffeecommunity6438

Appendix B: Ordered Situational Map of Circular Coffee Community

(Sensitive personal information and names have been anonymized using black boxes.)

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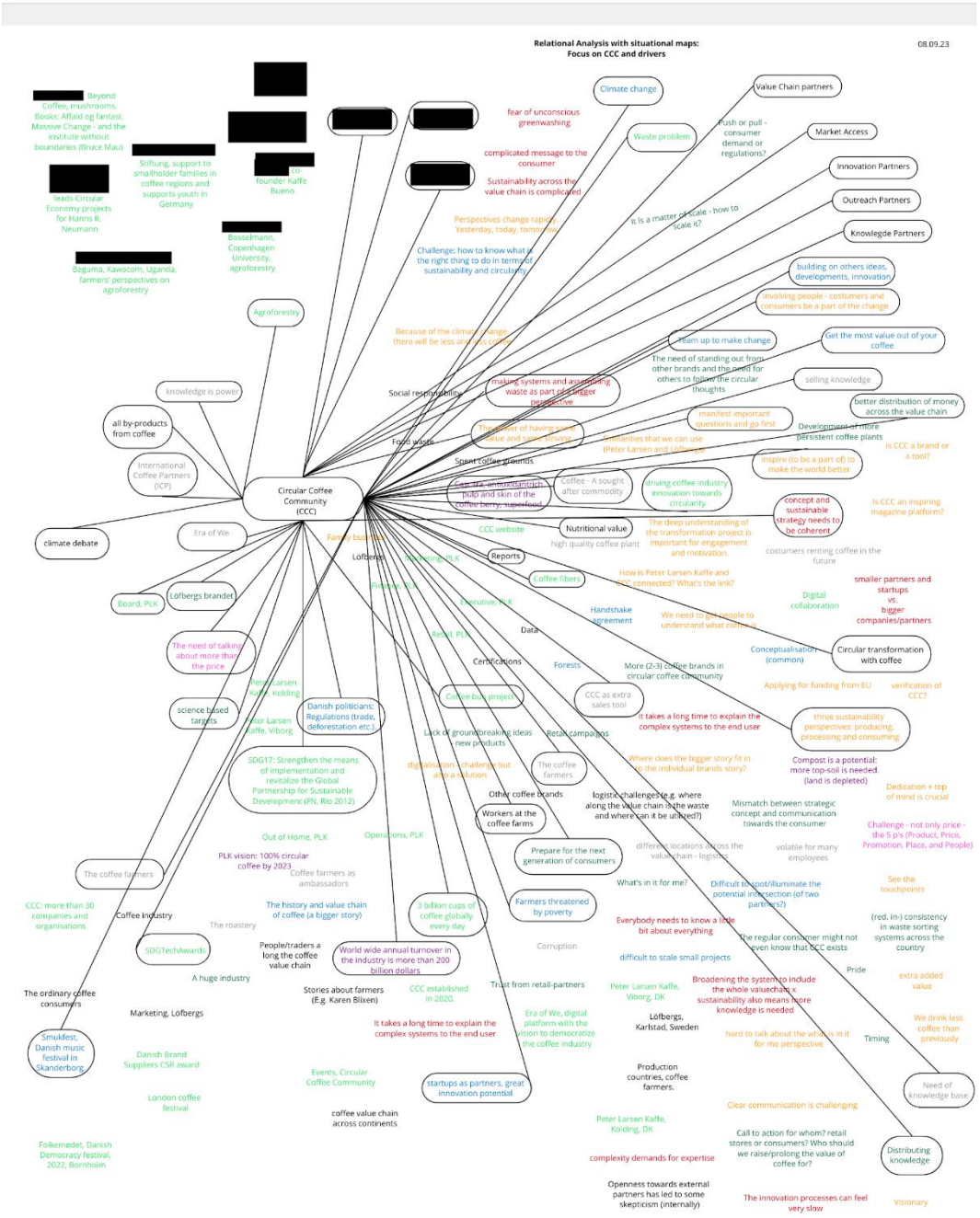
Appendix C: Relational Analysis – Circular Coffee Community and Drivers

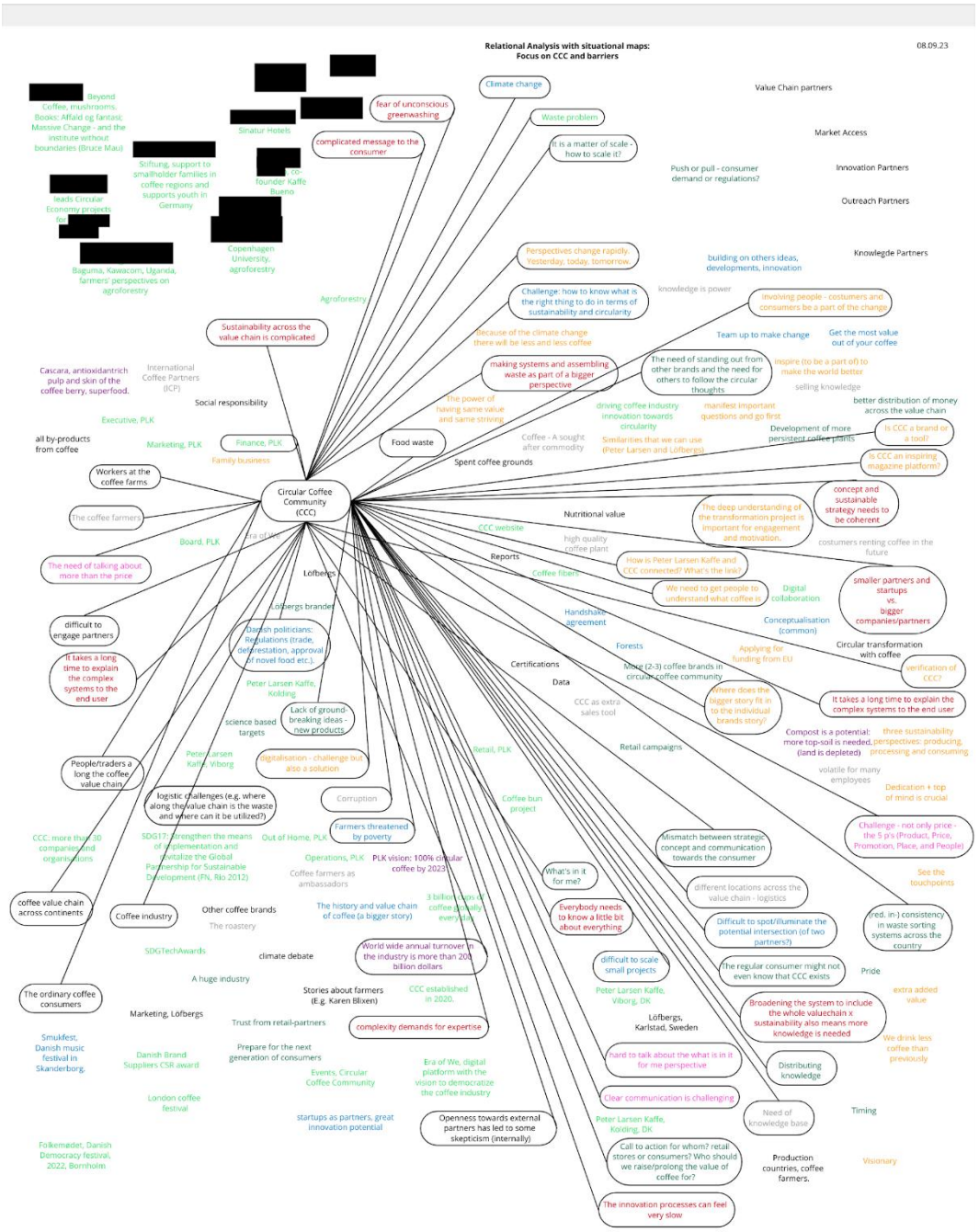
(Sensitive personal information and names have been anonymized using black boxes.)



Lindek, A. H.; Petersen, M. K.; Gudiksen, S. K. (2023). Relational Frictions in Circular Economy Ecosystems: Designing for Transformative Futures. *Strategic Design Research Journal*. *Volume 16,* number 03, Sept – Dec 2023. 295-314. DOI: 10.4013/sdrj.2023.163.02

Appendix D: Relational Analysis – Circular Coffee Community and Barriers

(Sensitive personal information and names have been anonymized using black boxes.)



Lindek, A. H.; Petersen, M. K.; Gudiksen, S. K. (2023). Relational Frictions in Circular Economy Ecosystems: Designing for Transformative Futures. *Strategic Design Research Journal*. *Volume 16,* number 03, Sept – Dec 2023. 295-314. DOI: 10.4013/sdrj.2023.163.02