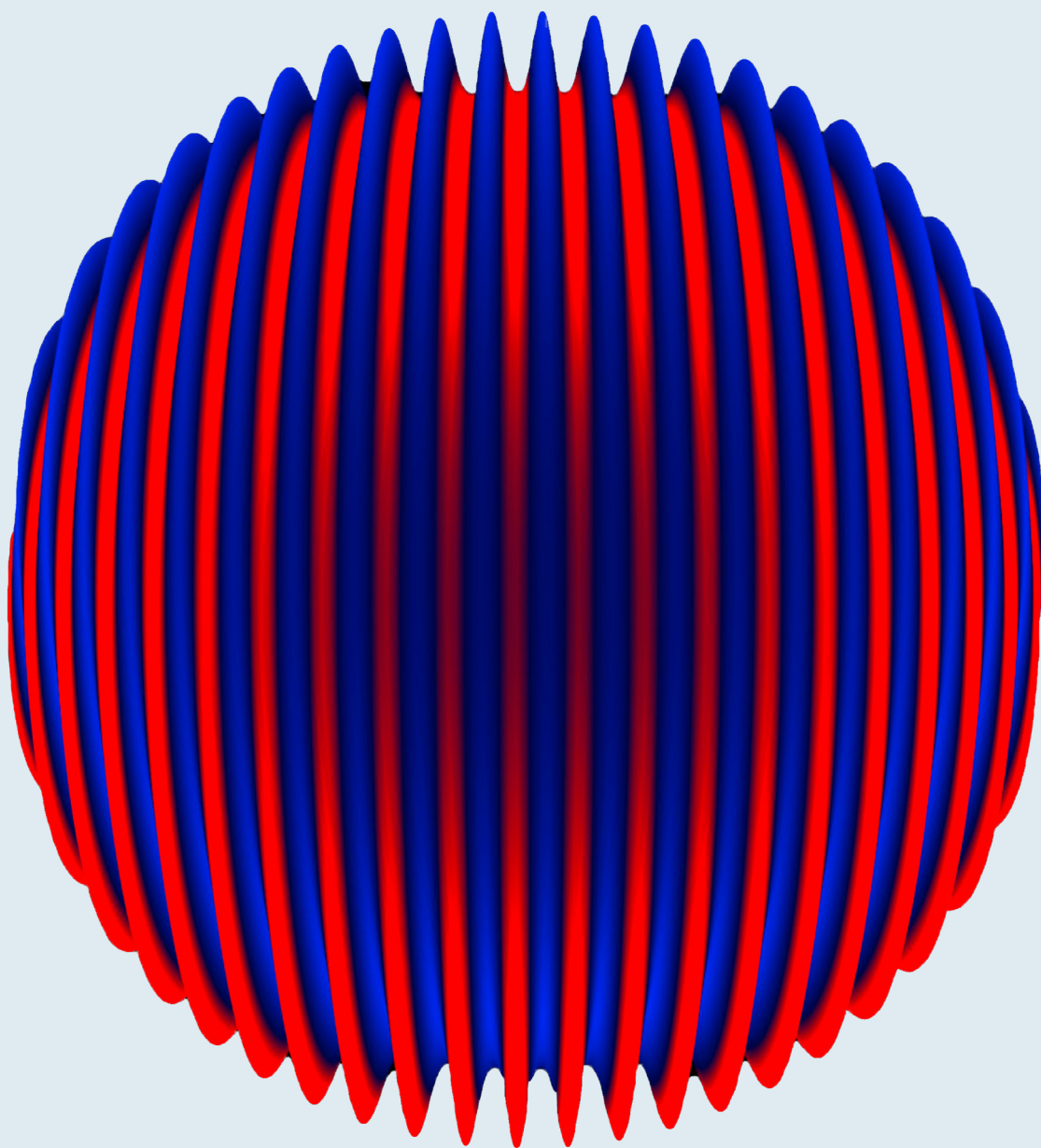




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ana thudichum vasconcelos

Victor M Almeida

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Katja Tschimmel

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Espresso-ing change: co-designing coffee's circular future

Fabiana Rovera¹, Alessandro Campanella¹ and Silvia Barbero¹

Abstract

The evolving design context demands cross-disciplinary approaches to tackle complex, worldwide issues such as sustainability and the Circular Economy. The paper traces the establishment and genesis of the Center for Circular Economy in Coffee (C4CEC), a novel initiative developed through a long-term partnership aimed at rethinking value creation in the coffee sector. C4CEC applies the Multi-Level Perspective framework and co-design to introduce a systemic change in the coffee sector by interacting with sustainability's environmental, social, and economic dimensions, not only as operational challenges but also as a redefinition of value beyond efficiency and growth. The paper highlights how the co-design process involves stakeholders, enabling situated and collaborative forms of design thinking that foster innovation and seek interventions to prominent themes like resource efficiency, minimal waste, and circular flows of production and transformation. Through Systemic Design, the research demonstrates how C4CEC is transforming the coffee supply chain and speeding up substantial, sustainable change. Finally, it identifies the pivotal role of co-design and systems thinking in enabling supply chain-scale circular change.

Keywords

Systemic Design, Co-creation,
Knowledge-sharing Frameworks

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Institutional Affiliation

¹Politecnico di Torino, Torino, Italy

Introduction

Collaboration is a crucial element for transformative change and transition to sustainable processes in the changing and dynamic field of the design profession. Given that today's issues are multi-faceted, plural and interconnected, the importance of diversity of thought and cross-disciplinary knowledge has increasingly become clear. 'Co-design', 'participation' and 'co-creation' (Lee, 2008; Steen, 2013; Zamenopoulos & Alexiou, 2018; Redlich et al., 2019; Antonini, 2021) are not mere buzzwords but rather transformational strategies that fundamentally change how designers approach challenge-solving.

Involvement of all stakeholders, from designers to users and other parties, is a necessity in co-design. This collaborative process is not only a means of enhancing design; it also helps us better understand complicated problems and to create tangible, concrete, and truly significant interventions.

This perspective, in detail, becomes more significant when applied to sectors characterized by global supply chains and significant sustainability challenges, such as the coffee industry. In this regard, issues associated with sustainability, such as those related to the use of resources, waste, and value distribution, are critical areas where systemic responses are required. The Center for Circular Economy in Coffee (from this point forward, C4CEC) is a novel initiative in which co-design and Systemic Design are used to support a more circular and sustainable change in the coffee supply chain. In this regard, this research aims to examine how collaborative and systemic approaches can support a more circular change, with the following research questions: *research question 1* - how can co-design, as implemented through the activities of C4CEC, support a systemic change toward a Circular Economy in the coffee supply chain?; *research question 2* - to what extent can a collaborative approach through stakeholder participation in C4CEC contribute to a new value distribution in environmental, social, and economic dimensions?; *research question 3* - to what extent can a cross-disciplinary and Systemic Design

perspective, as implemented through C4CEC, contribute to a more impactful change in the coffee supply chain?

1. Context and vision

Considering the aforementioned context, in 2021, a group of practitioners reconvened, each of them individually acting in their area, academia area (in the Systemic Design course and research at the Department of Architecture and Design (DAD), Politecnico di Torino, Italy) and company transformation area (on behalf of the activities of sustainability and Circular Economy of coffee processing, Luigi Lavazza S.p.A., Italy). Despite their different professional backgrounds, all group members were familiar with systemic thinking (Kim, 1999; Meadows, 2008; Monat & Gannon, 2015). Systemic Design forms the basis of the initiative, which encourages cross-disciplinary thinking in posing challenges and building interventions that consider the interdependence of all the parts of a system. The C4CEC follows a co-design methodology to enable cross-disciplinary collaboration in designing the supply chain's future. The coffee supply chain encounters historical issues, the majority of which are brought about by the rapidly increasing rates of climate change. For example, Arabica coffee is vulnerable to the effects of climate change in temperate tropical conditions at high altitudes. Demand for production to be relocated to higher elevations expands forest systems and increases environmental degradation, particularly in territories where regulatory constraints have been altered. Besides, the industry requires massive investment in regenerative agricultural systems, planting and applying climate-resistant strains of coffee, and redesigning farms to enhance water management and mechanization. The coffee supply chain impacts the environment and the economy, contributing to greenhouse gas emissions, biodiversity loss, water consumption and eutrophication. Economically, coffee production generates livelihoods for millions of individuals in over fifty producer countries, but smallholder farmers are disproportionately affected. They are ever more challenged by the climate change threat, competition for natural resources, soil erosion and mounting financial burdens. Added to the chronic price uncertainty and uneven value distribution in the supply chain, this undermines their capacity to achieve sustainable income levels. In this regard, it is becoming increasingly imperative to re-evaluate the management of resources in the coffee chain, especially those classified as waste. The coffee production process generates a variety of by-products, such as coffee pulp, husks, wastewater, spent coffee grounds, etc. that are often underutilized or discarded. However, by following the principles of the Circular Economy, these

materials can be transformed into valuable resources. Not only does valorizing these by-products reduce the sector's environmental footprint, but it also creates new economic opportunities for farmers and enterprises. This could involve, for example, extracting valuable compounds such as antioxidants or oils or creating new consumer products, in line with circular design strategies such as those promoted by the Ellen MacArthur Foundation and the 9R framework (e.g. refuse, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover), which emphasize closing material loops, extending product lifecycles, and designing out waste from the outset (Ellen MacArthur Foundation, 2015; Kirchherr et al., 2017).

The purpose of this paper is to explore the origins of the C4CEC concept, which was sparked by the long-standing collaboration between Sys – Systemic Design Lab (hereafter referred to as Sys Lab) and Luigi Lavazza S.p.A. (hereafter referred to as Lavazza). Specifically, the innovative research materials developed through this collaboration were handed over to the Lavazza Foundation because of the pre-competitive nature of the initiative. The transition from Lavazza to Lavazza Foundation is significant because the work with Sys Lab has highlighted the need to extend this approach to the entire supply chain from a pre-competitive perspective to have a real impact. The C4CEC concept came to life through a dynamic co-creation process involving a diverse group of influential partners. These included the University of Gastronomic Sciences (UNISG), the International Coffee Organization (ICO), the International Trade Centre (ITC), and the United Nations Industrial Development Organization (UNIDO).

In the following pages, the path that led to the creation and conceptualization of the C4CEC will be traced, while its concrete function within the coffee sector will also be analyzed. But before delving into this, it is worth briefly introducing the two actors at the origin of the project: Sys Lab and Lavazza. Sys Lab was formed by the DAD researchers of Politecnico di Torino, with a shared purpose to explore Systemic Design approaches, methods and tools for application in environmental, social, and economic sustainability. Lavazza is Italy's leading coffee roasting company. Founded in 1895 in Turin, it now operates in over 140 countries worldwide. The Giuseppe and Pericle Lavazza Foundation ETS supports the autonomy of local communities by emphasizing the value of female workers, involving younger generations, encouraging good agricultural practices to improve crop yields and coffee quality, and promoting the use of technological tools to counter the effects of climate change. From 2021, Sys Lab and Lavazza have collaborated on research journey to investigate sustainability projects, especially those with circular trajectories, to understand the mega-trends of the coffee industry and develop innovative

programs. The research aimed to leverage the company's internal strengths, enhancing its specialization while acknowledging the constraints imposed by the multilayered organizational structures typical of large, well-structured corporations. By proposing a collaborative system, the research approached the multi-skilled diversity of various actors and corporate competencies, bringing them together to create a stable foundation for cross-sector relationships and establish horizontal competencies. The effective systematization of the learnings highlighted the importance of a shared vision as a critical element for uniting stakeholders on a shared model built on goals and values. Systemic thinking has also introduced a new, holistic perspective on the company's business sector and value chain, which is characterized by complexity due to its long and fragmented chain of contacts (Barbero & Toso, 2010). This has positioned the research evidence and resulting recommendations within a broader, knowledge-based frame of reference.

The research also contributed to an experience stemming from the shared objective of the Coffee Network, an initiative launched by the International Trade Centre – Alliances for Action and Lavazza. The Circular Economy Working Group was established based on Systemic Design approach to construct a dialogue among diverse actors, from coffee producers to industry players. The initiative seeks to chart a new path that can overcome the barriers hindering circular transition in the industry (Van Keulen & Kirchherr, 2021) and harmonize the stakeholders' interests for the benefit of the industry. Even while the Systemic Design methodology effectively governs change processes' collaborative dynamics, a growing need emerges to formalize various experiences wherein this methodology has been the primary driver. This will help establish authoritative best practices and tools to tap and engage stakeholders in addressing emerging challenges. Building on this shared vision and the need for cross-sector collaboration, the next step in the journey was to define the concrete path towards a circular coffee sector, to design a participatory platform that could drive sustainable change. A platform where stakeholders come together, co-creating solutions beyond profit maximization, developing a shared vision of a circular and sustainable coffee industry. The initiative also aimed to define a common approach to an international research mission, bringing together scholars and practitioners from diverse geographical backgrounds to overcome current constraints.

2. Materials and methods

Using co-design and multi-level perspective approach methods, the two organizations, Lavazza Foundation and Politecnico di Torino, together with the other founder and

strategic partners (UNISG, ICO, ITC and UNIDO), engaged diverse stakeholders from academia and the coffee industry in developing innovative solutions and system change. C4CEC was created with a key input of co-design since it enabled the active participation of many stakeholders in the design and development process. The process fostered a spirit of collaboration, ensuring everyone's voice and that the interventions created were pragmatic and sector specific.

Nevertheless, co-design will remain a significant element in the creation of future C4CEC, as well as in designing meaningful impacts. With development and growth, the participatory process of the center will remain at the core of what it does, enabling constant co-operation among stakeholders and innovation and keeping the center's actions adaptive to the changing needs of the coffee industry. The participatory process will be central to developing long-term solutions and initiating long-term, positive change in the supply chain. The following paragraphs of this paper will explain the pivotal role of co-design and multi-level perspective approaches in the conceptualization and design of C4CEC.

2.1. The role of co-design

Co-design is a design methodology that re-initiates the dialogue between stakeholders and designers by engaging stakeholders actively in the development and design process. The stakeholders involved here are not passive recipients but are active participants, contributing knowledgeable insights from their real-world experience with the system. This transition puts the designer in a sole creator-to-facilitator role, overseeing a participatory process in which multiple stakeholders can define the best system to meet their needs (Sanders & Stappers, 2008). Co-design was at the heart of the C4CEC building because it allowed for constant interaction among corporate sponsors and researchers in an environment of collaboration. It enabled free exchange of all the stakeholders with specialized knowledge, drawing on long-standing experience accumulated over many years by organizations operating in the coffee sector from multiple perspectives. Certain co-design elements further customize their potential namely engaging and involving stakeholders, iterative and continuous feedback, diversity and inclusivity (Fig. 1). *Engaging and involving stakeholders* was marked by the successful collaboration between the six main parties and founders of the C4CEC, bridging the gap between industry practitioners and academic researchers. The academic partners providing a robust scientific foundation. In contrast, the other partners represent the industry perspective, contributing through sustainability initiatives, market information, and capacity-building efforts focused on developing countries. Through shared discussion and brainstorming,

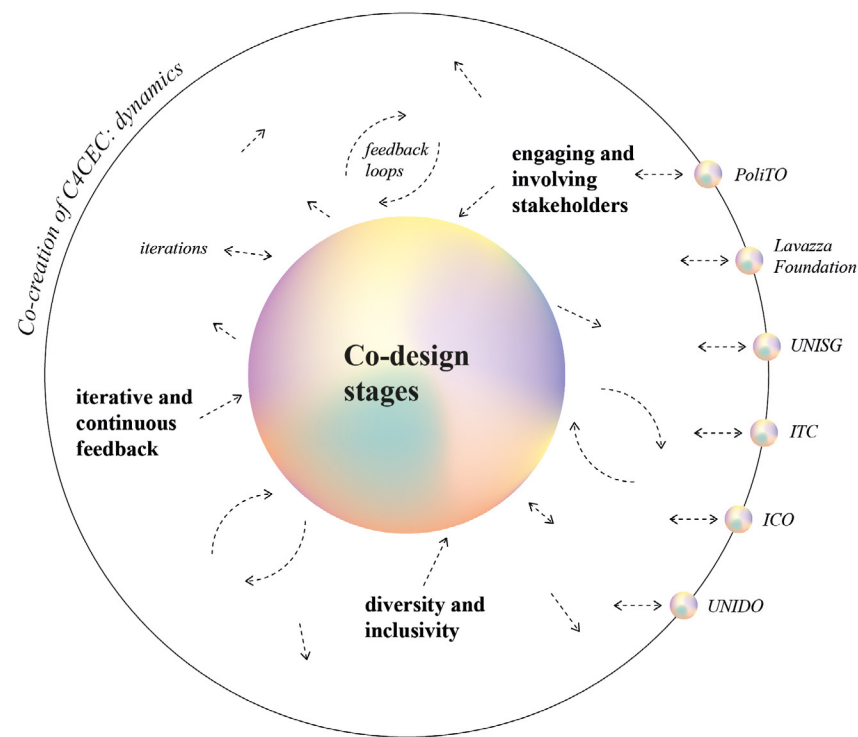


Fig. 1. Co-design stages in the co-creation of C4CEC. Source: Rovera, Campanella and Barbero (2026)

all the parties identified and addressed critical issues that affected the industry, such as waste minimization, green productive processes, and responsible consumption. All the participants actively participated in argumentation, expressing their hands-on experience and practical knowledge in critiquing and improving interventions and solutions. Iterative and continuous feedback was the central principle of the co-design methodology, allowing incremental improvement and development of concepts. The six partners engaged in an iterative and continuous feedback loop for approximately one year while establishing this third-sector organization. Meetings and exchanges happened regularly, allowing the partners to intensely discuss and refine the entity's structure, form, and objectives. The feedback primarily focused on clarifying the organization's mission, operational goals, and governance model. As a result, the final objectives were clearly defined and can be summarized as promoting circular economy culture and knowledge, collecting and sharing good practices, piloting projects and conducting research. The ongoing feedback was incorporated through continuous revisions of proposals and strategic plans until consensus was reached, fostering a shared vision and strong foundation for the organization. Feedback was provided both face-to-face and online, using communication platforms that enabled stakeholders to connect in real-time, even when located in

different time zones. The feedback loop ensured that interventions and solutions were adaptive in nature, changing themselves according to stakeholders' changing insights and requirements. Iteration resulted in a responsive, adaptive design oriented towards ongoing improvement to provide the best for all involved goals and needs. Diversity and inclusivity were also some of the guiding principles of co-design, particularly in addressing the complexity of sustainability within the coffee value chain. Stakeholder diversity and the presence of many voices in the room were instrumental in making the design work, particularly in addressing the challenges and complexities of the coffee value chain. Overall, these ideas illustrated the power of co-design in generating adaptive and participatory solutions that could solve complex problems while mitigating unintended consequence.

As a result, multiple innovations and interventions were developed, such as the co-creation of training courses on the implementation of circular economy practices in the coffee value chain, the identification and documentation of best practices in a dedicated database for the valorization of coffee by-products, and the development of guidelines to support stakeholders in the implementation of circular economy strategies in different stages of the coffee value chain. These initiatives were complemented by a diverse number of pilot projects and the promotion of the principles of the

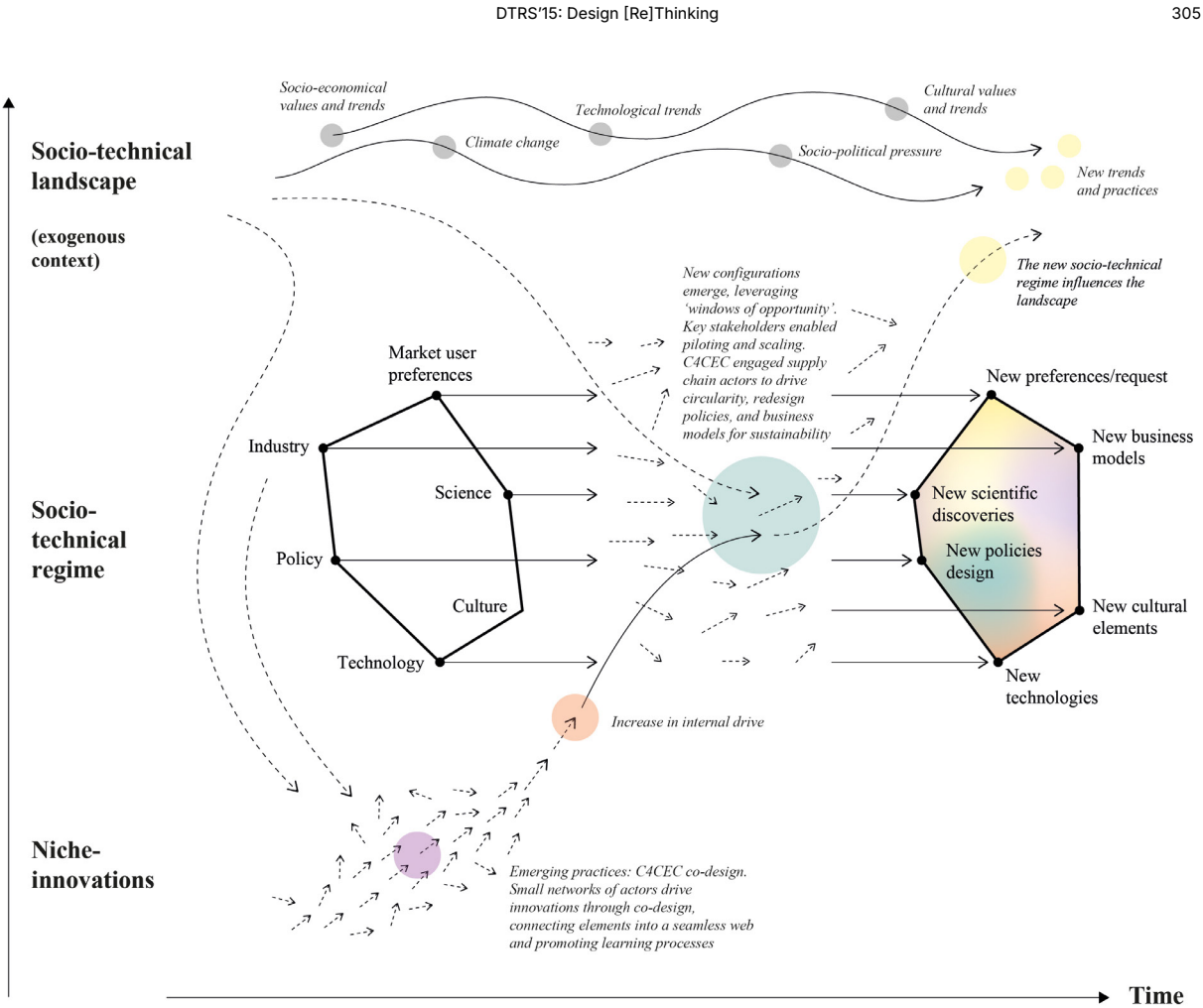


Fig. 2. Multi-Level Perspective framework. Source: Authors' elaboration (Rovera, Campanella and Barbero, 2026), adapted from Geels (2022, 2011)

circular economy throughout the supply chain, such as the participation in numerous conferences and events focused on the dissemination and education on the benefits of the Circular Economy.

2.2. The multi-level perspective as a vehicle for transition

Operationalize the MLP framework: Explain more explicitly how the framework informed decisions, interventions, or evaluation within the project. Apart from co-design, the Multi-Level Perspective (from this point forward, MLP) (Geels, 2011) helped define the perception and reaction to the diverse impacts across all levels of the coffee value chain when it transitioned to a Circular Economy. MLP identifies that system transformations occur across various levels, such as niche innovations, socio-technical regimes, and landscape dimensions. Along these levels, the design process becomes more efficient in responding to the interdependencies of the many actors and drivers involved within the coffee value chain. These developing

interventions are more scalable and more effective (Fig 2).

Niche Level - emerging innovations: at the niche level, they applied a co-designing process to develop innovations and interventions to induce sustainable behavior in the coffee business. They included new technologies and practices for minimizing and valorizing waste and by-products, green processing techniques, and circular business models. The simultaneous involvement of the Lavazza Foundation, the International Coffee Organization, the International Trade Centre and the United Nations Industrial Development Organization facilitated the piloting and scaling up of real-world solutions. Niche level is also significant since niche innovations gain momentum when expectations get more crystallized and accepted by the broader population, learning processes converge to develop stable configurations (i.e., 'dominant designs'), and networks grow, particularly with the participation of influential actors who offer legitimacy and resources to the innovations (Elzen et al., 2004; Geels, 2004). The application of the MLP on the niche

level facilitated the identification of the innovations that had the potential to impact system change. Evaluation criteria considered the adoption rate, effectiveness in waste reduction, and the engagement of stakeholders.

Regime Level - changing deeply ingrained habits: the regime level entailed an even more profound challenge, the ingrained practices, business models, and policy designs that structure the market for coffee. C4CEC directly attempted to drive through these regimes by engaging the central supply chain actors and spearheading a shift towards more sustainable and Circular Economy operating practices. The focus was redesigning policy interventions and business models to integrate circularity into routine operational practices and all stages of products, waste and by-product lifecycles. At the regime level, the MLP assisted in targeting areas for intervention based on structures, rules, and routines that shape the coffee industry. The evaluation perspective focused on changes in operational practices, adoption of circular economy models, and how these changes were integrated into dominant designs.

Landscape Level - management of externally originated drivers: the landscape level is similar to Braudel's *longue durée* (Geels, 2011) and encompasses external drivers influencing the coffee sector, such as climate change, trends in international regulation, changes in consumer tastes, demography, political ideology, and societal values, which cannot be directly altered in the short term but decisively shape sector dynamics (Geels, 2004). C4CEC aligned its mission with these global trends towards sustainability, and it was amongst the central players in reworking the coffee sector. The MLP was also followed in monitoring external drivers such as climate policies, consumer behavior, and global sustainability agreements. This knowledge informed strategic decisions, with niche and regime interventions being consistent with long-term trends. The evaluation process was based on measuring the ability of innovations to withstand external drivers and the alignment of project results with macro-level sustainability drivers.

In tackling these three levels (niche, regime, and landscape) C4CEC could contribute to a holistic approach to sustainability, leading to system change across the coffee sector in harmony with global standards for a Circular Economy.

3. Results

The combination of co-design and MLP was a robust methodological configuration for developing C4CEC. Co-design facilitated stakeholder participation at all levels, enabling the creation of effective and sustainable actions and solutions, while MLP provided a strategic lens for understanding and addressing the complexities of the coffee industry.

Co-design facilitated innovation and technology development at the niche level. At the regime level, the process involved collaborating with leaders in the supply chain to transform established practices and introduce Circular Economy thinking. At the landscape level, the MLP ensured that C4CEC actions were coordinated with global developments generally, so the center was a leadership influence on the global agenda for sustainability. Thanks to its strong methodological foundation, C4CEC has transitioned from a conceptual framework to a concrete operational entity, positioning itself as the world's first pre-competitive platform dedicated to advancing Circular Economy practices in the coffee sector. The Center provides a platform to implement Circular Economy principles, experiment with innovations, lead research, and share best practices, solutions, case studies, and practical information on Circular Economy applications throughout the coffee value chain.

C4CEC also contributed to the development of a multi-stakeholder knowledge-sharing platform, aimed at promoting evidence-based best practices for the valorization of coffee by-products. This initiative included the mapping of existing best practices within the coffee supply chain, presented in a dynamic and evolving resource aimed at showcasing and promoting circular approaches in the sector and, additionally, a series of international webinars named '(Re)generating value through circular economy in coffee', co-hosted by ITC, ICO, Fairtrade, and the Specialty Coffee Association, focusing on circular economy, value regeneration and coffee circular solutions. These initiatives contributed to fostering shared innovation, improving business practices, and identifying opportunities for small enterprises in coffee-producing regions, while also addressing challenges related to implementation and scalability.

Additionally, the C4CEC supported academic collaboration to rethink the coffee supply chain from a systemic perspective. In partnership with three universities – the Politecnico di Torino, the University of Gastronomic Sciences of Pollenzo and the Raffles Milano International Design Institute – several projects involving more than 50 students were developed to explore innovative and sustainable approaches within the sector. These included strategies to promote local coffee consumption in Kenya territories, solutions for the valorization of coffee by-products and initiatives addressing market access and sustainability challenges in different producing regions.

4. Discussion

Developing the C4CEC as a collaboration is evidence of a heightened passion for systems thinking and sustainability in the coffee industry, which has environmental concerns

regarding waste, resource use, and supply chain sustainability. The Circular Economy idea addresses these issues, emphasizing reuse, recycling, and regenerating products to make the coffee value chain more ethical and sustainable. Systemic Design drives this transformation, guiding and implementing Circular Economy ideas in the industry. By leveraging researchers' systemic design potential, the project charts interdependence all through the coffee economy, touching upon locations of the highest leverage for change while maintaining the feasibility of scalable and adaptable interventions. The work extends beyond the coffee sector; Systemic Design serves as a model for industries aiming to integrate Circular Economy principles into their operations. The project can motivate other industries to tackle long-standing environmental and social challenges by demonstrating the potential of co-design, systems thinking, and collaboration, creating new circular patterns of production, consumption, and waste, shaping new business models and promoting sustainable relationships between producers, consumers, and other actors.

Conclusion

Overall, the synergy of co-design, co-creation, and collaboration in the design process offers a novel approach to facing the complex, interconnected issue of sustainability. As seen in developing initiatives such as the C4CEC and its emphasis on systemic thinking and circularity, these approaches are critical in forging innovative and sustainable interventions and solutions. By sparking diverse perspectives and engaging involved actors, industries and local communities, such a process creates designs that reflect diverse groups yet are better equipped to solve real-world problems. The iterative nature of co-creation ensures solutions are ever-evolving to meet emerging needs, thus making them both resilient and relevant to an ever-changing world.

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AI Use Disclosure

The authors used AI-assisted tools in selected parts of this manuscript solely to improve writing clarity and readability. All intellectual content, analyses, and conclusions are entirely the authors' own.

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