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Article

Why Do Companies Pursue Collaborative Circular Oriented Innovation?

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Abstract: We investigate why companies collaborate within the circular oriented innovation process. The purpose is to understand what motives trigger collaborative circular oriented innovation, as well as conditions, drivers and barriers. First, we define circular oriented innovation building on sustainable oriented innovation literature. Subsequently, we investigate 11 leading circular economy companies operating within the Netherlands, who developed collaborative circular oriented innovation activities. ‘Hard’ and ‘soft’ dimensions for innovation are identified and applied to delineate the drivers and barriers for collaborative circular oriented innovation. Our findings indicate that collaborations are conducted by entrepreneurially-minded actors through sharing a vision, enthusiasm, and crucially, a credible proposition for a circular economy. Furthermore, collaboration is sought early, to co-develop the problem and solution space and integrate disparate knowledge from across the value network, to mitigate increased complexity. Motives to collaborate vary between personal and organisational, and intrinsic and extrinsic levels. Collaborations start based on a relational basis between ‘CE front-runners’ to advance knowledge through experimentation. ‘Soft’ challenges to advance collaborations towards the competitive remain around culture, and the mindset to share rewards and risks. Without suitable solutions to these challenges, collaborative circular oriented innovation could remain underdeveloped within the transition towards the systemic level.

Keywords: circular economy; circular oriented innovation; sustainable oriented innovation; collaborative innovation; circular drivers and barriers; circular experimentation

1. Introduction

Growing concerns about the over-consumption of finite resources contributes to increased calls for a transition to a more sustainable society. Sustainable oriented innovation (SOI) research (such as [1–4]), explores the process, decisions, and the transition potential that is related to integrating a holistic view of sustainability into innovation. Innovation here is defined as the act of creating significant change or novelty through the “development and implementation of new ideas by people who over time engage in transactions with others” [5]. Implementation, diffusion and acceptance within markets distinguishes innovation from pure invention [6]. Innovation success is therefore dependent upon both the technical advancement and the creation of markets, which requires active learning and creative entrepreneurial processes [7,8]. Freeman [9] shows that such activities produce waves of emergence and consolidation that can lead to network-building. Dougherty and Dunne [7] further propose that such organisational networks should be actively encouraged to connect disparate ideas that support market

creation activities. The rationale for SOI compared to traditional innovation is that businesses can become key actors within sustainable transitions. This requires strategically changing their operations to create beneficial impacts from their economic activities that seek sustainable growth through innovation [6,10,11]. SOI, therefore, goes beyond traditional innovation by changing a company's values to purposively create environmental, social and economic value. This is achieved through combinations of innovations in process, product, organisation, business model and market [6,10,12]. A key identified success factor is interorganisational collaboration [13,14], as increased sustainability impacts also require increasingly to innovate at the system level, which cannot be done alone. Yet, this increases complexity and the pursuit of radical innovation and learning approaches, which therefore also requires the 'unlearning' of established ways of doing things [10,15].

The circular economy (CE) concept, which is emerging within the sustainability field [16–21] is systemic and commonly seen as collaborative, and is argued to hold the potential for radical solutions for a sustainable society. Although Blomsma and Brennan [17] identify growing excitement about the CE concept, they argue that this needs to translate into the validation of claims to overcome uncertainties, and to prove that it can be operationalised. Here, collaborative innovation is seen as being required to create sustainable system impacts, which is supported through increased experimentation and the upscaling of CE solutions to contribute towards sustainable transitions [10,22–25]. Collaborative circular oriented innovation (COI) is also central to both the European Union (EU) and Dutch government's sustainable future vision and strategies [26–29]. Collaboration is also central to the recent memorandum of understanding for the CE signed between China and the EU [30]. The assumption is that such collaborative COI activities will drive radical sustainable changes within research and innovation actions, create jobs, economic value and reduce environmental impacts [26,27]. Understanding why such collaborative COI activities begin, how they relate to other sustainable oriented innovation approaches, and what the associated challenges are, is paramount if CE is to endure and not become another sustainability buzzword. However, only a few studies empirically engage with understanding the motives for why companies engage collaboratively within the CE context; it is usually simply seen as an inherent element. Our intention is to unpack this process.

Recent SOI literature has delineated specific drivers, barriers and success criteria that provide insights into how collaboration relates to such innovation actions [6,10,14,31–33]. However, the literature does not explain the extent of differences or similarities, which raises the question, of whether CE innovation is an emerging subset within sustainability. "What are the motives, barriers and drivers that stimulate or hinder collaborative innovation within the circular economy context?". Answering this will develop an understanding of the rationale, conditions, and collaborations to promote increased circular oriented innovation. The purpose and scope of this study is therefore explorative in nature.

The remainder of the paper is structured as follows. First, we review current literature on CE and SOI, with specific reference to the associated drivers and barriers. A categorisation of 'hard' and 'soft' drivers, and barriers to innovation is used. Second, to find out from practice why companies have sought collaboration, we investigate 11 CE-oriented companies operating within the Netherlands. Finally, we propose a framework to describe why companies collaborate, based on our findings, which is used to support the discussion and conclusions that are subsequently presented.

2. Literature Background

This section introduces the key concepts and the development of the academic discussion on sustainable oriented innovation and the circular economy to first conceptualise the notion of circular oriented innovation. Their relations to collaborative innovation are discussed. Subsequently, the current drivers and barriers related to collaborative circular oriented innovation are discussed, based upon literature findings.

2.1. What Is Circular Oriented Innovation?

Circular oriented innovation represents a new area of research drawing upon sustainable oriented innovation literature, and incorporating developments within circular economy (CE) research. CE has grown quickly, with many scholars aiming to define what it is, and why it challenges the status quo. The dominant view is that the concepts within CE are not new in themselves, but it is their specific combination and scope that creates challenges to present a unified vision and implementation [17]. As such, CE can be categorised as being pre-paradigmatic, where no single paradigm exists, with guidance and consensus still forming [18]. Recent analysis by Kirchherr et al. [20] of 114 CE definitions, with 95 uniquely given, indicates this clearly. To overcome this challenge, Masi et al. [34] deviate focus from the specific antecedents and definitions to the interconnecting goals and principles that are central to support a common CE vision. They include: (1) replacing linear systems with intentionally designed regenerative and restorative circular systems, (2) decoupling economic growth from non-renewable material throughput and environmental degradation, (3) increasing system resilience and (4) maximising value creation, capture and recovery across economic, social and ecological values. These four goals indicate the necessity for a systemic approach. Bocken et al. [35] propose to achieve this through developing a CE vision in conjunction with combinations of CE product design and business model innovation strategies to design systems that slow, narrow or close resource loops. Den Hollander [36], advances this by developing a heuristic design framework that combines CE strategies linking potential product use and lifecycle stages to associated business models. The aim is to maximise the product integrity and manage obsolescence through design. This requires up-front knowledge of specific CE design strategies and product criteria that are linked to recovery operations such as reuse, reparability, refurbishment, remanufacturing and recycling, hereafter termed CE recovery strategies [35–38]. This essentially means that innovators need to design with the knowledge and requirements of such a potential value network early, and plan for engagement across the full life-cycle. Circular oriented innovation (COI) is therefore defined here as the coordinated activities that integrate CE goals, principles, and recovery strategies into technical and market-based innovations, such that the circular products and services that are brought to market purposively maintain product integrity and value capture potential across the full life-cycle.

2.2. How Does Circular Oriented Innovation Fit within Sustainable Oriented Innovation?

Sustainable oriented innovation approaches interact with all levels of business strategy and manifests in different dimensions (e.g., product, process, organisation and business model) and levels of ‘radicalness’.

First, a systematic review by Adams et al. [10] distinguishes three dimensions that are related to the integration of product design, business models and a systems approach. They explore whether sustainable oriented innovations are: insular or systemic, going beyond immediate stakeholders, either stand-alone or integrated with regard to sustainability within the organisation, or whether the innovation focus is technological or socio-technical. Using these dimensions, they propose three approaches, which are operational optimisation, organisational transformation and system builders. The system builder approach is considered to be the highest order, but the least found approach, where the innovation objective is the creation of net positive impact and societal change [17]. Work by Ceschin & Gaziulusoy [39] on the design for sustainability also distinguishes strategies across the product, business model, and systems level, demonstrating increasing sustainable transformations. These authors position CE at the highest systemic level within SOI, and emphasise how CE thinking has evolved from, and builds on other SOI approaches. They also identify that increased potential sustainability impacts are linked to increasingly systemic innovation. Here, both systemic SOI approaches and COI requires active leadership that pursues business motivations, whilst recognising interdependence and actively engaging with new and diverse networks of actors to create sustainable business models at the network level [3,33,40–42].

Second, SOI may be incremental or radical, based upon strategic choices, and the context and scope of the intended innovation activity [6,43]. The key distinction is whether the innovation is a modification of a previously accepted process, product, service or technology, or whether it is wholly new and disconnected from the current context [43,44]. Although both forms of innovation activities are important for SOI, radical innovation has a higher potential for influencing sustainable development across industries and systems, but it is more challenging to predict the impacts [6,10,43]. This correlates to an increasing requirement for inter-organisational and cross-sectoral collaborative activities, which De Medeiros et al. [14] identified as a critical driver for SOI success. Further work by Hojnik & Ruzzier [45] shows this to be especially true within the development/innovation stage. These relationships are summarised in Figure 1, with SOI approaches and design strategies listed in Table 1. This shows that like other systemic SOI strategies, COI requires innovations at all levels (e.g., process, product, organisation, business model) to enable systemic change, but it also requires changes from the firm’s strategy, engagement with society, and the way in which value is created. However, it is unclear whether there are further differences for why companies engage collaboratively or whether COI has reached the systemic level.

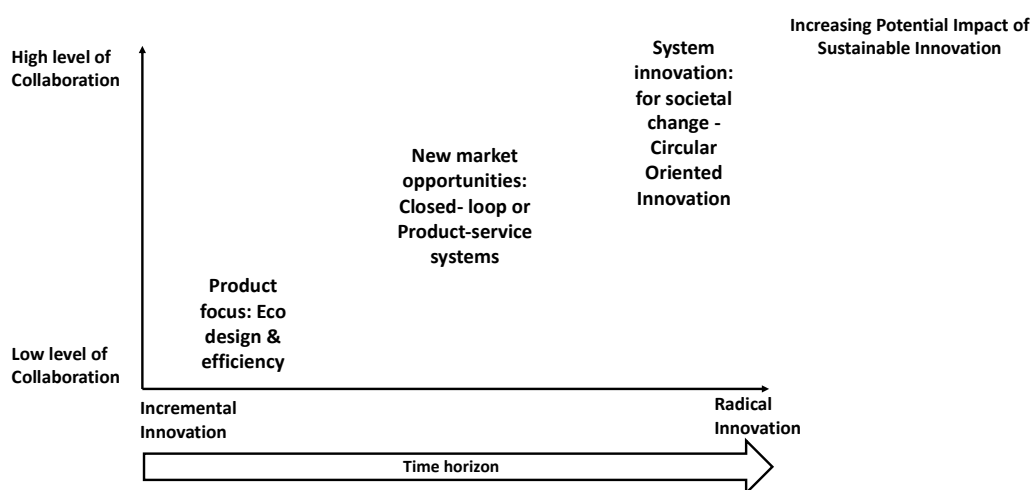


Figure 1. Evolution of sustainable oriented innovation and collaboration (adapting and integrating [10,39]).

Table 1. Sustainable oriented innovation and design approaches (adapting and integrating [10,39]).

	Product Focus	New Market Opportunities	Systemic Innovation
Sustainable Oriented Innovation Approach	Operational optimization: Eco-design and efficiency	Organisational transformation: New market/sustainable opportunities	System Building: For positive societal change
Objective of Innovation	Compliance & efficiency to do better	Novel products, services and business models to do good	Novel products, services and business models that are impossible to do alone
Outcome of Innovation	Reduce harm	Create shared social, environmental and economic value	Derive new and shared net-positive value configurations to drive societal change
Innovations relation to firm’s strategy	Incremental improvements to business as usual	Shift in the firm’s purpose—to do good and to create wider benefits	Extension of firm’s purpose—to be a part of society and to drive institutional change
Design Approaches	Product level—e.g., Eco, emotionally durable or base of pyramid product design	Product-service, servitisation or closed-loop systems	Systemic design for innovation and transition, Circular product design and business models
Organisational learning	Mobilising existing innovation capabilities—mainly firm level	Importance of leadership to engage value chain and stakeholder network to gain and generate knowledge	Novel (cross-/multi-sector) collaborations generating dialogues, foresight and experimentation

2.3. Towards Understanding the Motives for Collaboration in Circular Oriented Innovation

Circular oriented innovation is a novel and little understood concept. However, we can learn from collaborative innovation literature to incorporate existing insights, as COI is collaborative by nature. The literature shows that the primary motive for exploring collaborative innovation is the increase of knowledge flows [46]. Other commonly held motives include considerations for increased competitiveness and the market share of innovations, as well as access to resources, new markets, or enhanced skills. Additionally, such pursuits may relate to: increased performance, as well as the reductions in costs and the time to market [12,47,48]. Collaborative innovation also allows for the ability to share associated risks [12,47]. However, collaborative innovation has many challenges to overcome, such as the potential loss of control, or opportunistic behaviour that results in issues of trust that raises the need for robust partner selection [12,48]. These elements are increased for sustainable and COI activities. This is due to specific motives that are identified for engaging in radical sustainable innovation, which can be to seek a reputation as a green company, or a sense of ecological responsibility [31]. This shows that SOI holds normative values, going beyond traditional innovation, through a focus on why innovation is sought to overcome societal and environmental problems, and to propose solutions. Potential collaborating partners in SOI therefore need to be aligned more closely [13,31,49]. Dangelico and Purjari [31], however, put forward two caveats, one being that motivation alone is not enough, but that an organisation needs to translate its motives and vision into internal sustainability policies and targets. This also acts as a signal to potential partners on the suitability to collaborate. The other caveat is the potential market success of the proposed innovation, which acts as an important feasibility maker. These elements are also linked to findings from Klewitz et al. [6] and Adams et al. [10], who both indicate that pursuing increasingly radical SOI requires organisations to integrate and root sustainability into all levels of innovation, especially the business model.

2.4. Drivers and Barriers for Collaborative COI

Research on COI drivers and barriers is nascent, but it can build upon research into collaborative innovation, SOI and early research on CE. Based on this, they can broadly be categorised along ‘hard’ and ‘soft’ dimensions (Table 2), which are essential for understanding collaborative activities between companies. Our categorisation expands upon the dimensions proposed by De Jesus and Mendonça [50], whereby we include further explanation of what is included within the analysis.

Table 2. Hard and soft drivers and barriers.

	Dimension	Explanation
Hard	Technical	Technology, technical knowledge and skills, data, supply network operations, infrastructure, material and product design
	Market	Business model, contracting and accounting processes, economic and financial assessment
Soft	Social/Cultural	Organisational, individual and societal—mindsets, ideas, customs, values, behaviours or norms
	Institutional/Regulatory	Legislative, taxation, regulations, policies

The ‘hard’ drivers and barriers for COI derive from the required systems perspective which increases the level of complexity and interdependency, which motivates increased collaboration. Collaboration increases the ability to assess the feasibility or suitability to integrate CE recovery strategies, business models, value network combinations, and the required processes to operationalise COI [18,21,51,52]. Such explorations are motivated by the desire to understand and develop circular resource flows, and potential new value capture opportunities or reduced impacts, but these are hard to assess or quantify [24,35,53–55]. These activities also need engagement across the value network to explore potential tensions [36]. COI therefore motivates experimentation and collaborative learning styles [56], as the resources, knowledge, capabilities and infrastructure are dispersed across

interdisciplinary actors [57,58]. Thus, the complexity of the problem, coupled with the availability and distribution of knowledge, are key factors that motivate the collaborative innovation strategy and the intensity [46,59]. This idea builds upon Powell [60], who showed that networked learning and innovation are sought when there is a fast pace of transition, a distributed nature of knowledge and when required changes are industry-wide. As COI represents a fast, radical, and system-wide innovation and transition process, we assume that access to such CE-oriented networks are crucial for sourcing partners for experiments. This will additionally present the need to access suitable contexts for experimenting and scaling up ideas within and across value networks, to gain insights into feasibility, which is expected to further motivate collaboration [52,56,58,61,62].

The skills and competencies that are required for undertaking COI represent 'hard' drivers and barriers, but the 'soft' dimension also plays a role. This is reflected in two connected findings of recent work by Sumter et al. [63], that focus upon the required competencies for designers within CE. They identify that designers need increased 'hard' capabilities of foresight and the assessment of impacts across multiple life-cycles and the system level. However, crucially, they identify the need for increased 'soft' skills to collaborate with stakeholders who are able to operationalise the CE business model. Such requirements to develop new competencies for COI are likely reflected across the whole network, as De Medeiros et al. [14] shows that in SOI, the development and maintenance of an innovation-oriented learning culture is critical to success. This is described as an organisation's ability to adapt its own vision, develop competencies, and allow critical reflective analysis through innovation. Such learning is required to overcome barriers, especially cultural barriers to exploring sustainable opportunities. We propose this is increasingly true for COI. Furthermore, having the 'soft' skills to translate and communicate CE complexity into a clear future vision that identifies the desired circular impact is crucial. This is needed for the internal strategic processes, but it is also essential for developing the external collaborations that are required [6,35,64,65]. A sufficiently clear CE vision allows potential collaborative partners to assess the feasibility of such a collaboration, and to crucially determine whether the proposed vision and objectives align with their own [47,49]. Here, Adams et al. [10] note that one of the key barriers for 'system builders' is to involve the right partners to co-develop insights into the specific challenge, and to co-define what the problem actually is, or whether it is shared. This indicates that potential collaborators are required to balance both the 'hard' and 'soft' drivers and barriers.

An analysis of CE literature against these 'hard' and 'soft' dimensions is conducted, with focus being drawn to COI and collaboration to present the CE drivers (Table 3) and CE barriers (Table 4). An overarching driver for CE innovation is shown to be the desire to become a 'CE front-runner'. This is linked to reputation-building and the pursuit for new innovation, business opportunities, and emerging markets through experimentation. This in itself creates a driver for CE, as Kirchherr et al. [55] suggest that an increase in front-runner pilots, proof of concepts and the marketisation of CE innovations could motivate others to follow suit. Additionally, Fischer and Pascucci [66] identify that the creation of new contracting procedures, such as dynamic earning models and collaborative contracts that share risks and rewards, are needed to mitigate 'hard' barriers. Masi et al. (2017) argue that these are needed to create new collaborative supply chain configurations to facilitate circular transactions. Indeed, 'soft' dimensions of the company culture, current risk aversion, mindsets, and the 'hard' dimension of the position within the value chain are shown to affect the ability to develop these effectively. The majority of other drivers and barriers presented are 'soft' policy-oriented, and they aim to change the landscape through incentivizing circular activities in relation to traditional linear processes. These include discussions around the creation of favourable CE subsidies, regulations, legislation and capital support in the form of public funding or CE procurement [55,67].

Table 3. Circular Economy drivers for circular oriented innovation (1) and collaboration (2) as assessed from the literature.

		Drivers	Ref.	Relates to	
				1	2
Hard					
Technical		Increased availability of information and communication technology (ICT) facilitating resource optimisation for CE strategies	[50]	✓	
		Development of platforms for sharing/reusing solutions for products, materials and data	[50]	✓	✓
		CE enthusiasm and pilots generating the desire to experiment, generating proof of concepts at scale	[55]	✓	✓
Markets		Anticipated cost reduction and financial profitability	[34,50,54,66,68]	✓	
		Material criticality. Increasing the desire for stable, resilient and sustainable purchasing	[34,50,54,66]	✓	✓
		Recognition of awards or favourable treatment in government tenders linked to sustainability	[54]	✓	
Soft					
Social/Cultural		Increasing awareness and literacy from the demand side (customers). Brand reputation gains, and protecting the future right to operate	[34,50,54,69]	✓	
		Desire to be CE front-runners, successfully installing the environment and CE culture	[54,55]	✓	
		CE front-runners joining like-minded networks for CE development	[54]		✓
Institutional/Regulatory		Awareness of new standards, and increased environmental and waste legislation and regulations	[34,50,66]	✓	

Table 4. CE Barriers for circular oriented innovation (1) and collaboration (2) assessed from the literature.

		Barriers	Ref.	Relates to	
				1	2
Hard					
Technical		Lack of CE technical knowledge and skills, e.g., product design	[50,54,55,67–69]	✓	
		Position within the value chain, coordination, contracting and existing distribution channel arrangements, creating lock-in	[34,54,55,66,67,69]	✓	✓
		Take back/reverse logistics—quality, access and attractiveness of recovered products and materials. A lack of clear responsibility or ownership across the value chain	[34,55,66,67,69]	✓	✓
		Lack of data reducing the assessment of CE impacts, decision making and the validation of environmental impact	[34,54,55]	✓	
		Complexity to integrate technical innovations across the product, supply chain and BMs, creating technology gaps	[34,50,69]	✓	✓
		Current limited proof for CE technology and business models	[55,66]	✓	
Markets		Lack of resources or access to capital for high up-front costs and administrative burdens, creating lock-in or a lack of ability to engage with CE	[34,50,55,66,68,69]	✓	✓
		Uncertain or misaligned returns and/or incentives for investments into CE across the value chain—reducing the willingness to change or collaborate	[34,50,55,66,67,69]		✓
		Financial assessment, accounting and return on investment (ROI) based on linear concepts of rapid returns—Circular business models not seen as profitable or generating split returns	[34,50,54,55,69]	✓	✓
		CE contracting to share value across actors	[34,55,66]		✓
		Low virgin material or new products prices, creating unfair competition	[55,67]	✓	

Table 4. Cont.

		Barriers	Ref.	Relates to	
				1	2
Hard					
Soft					
Social/Cultural		Limited support/slow acceptance from the demand side (customers) for CBMs; e.g., the product as a service, and the supply side (supply chain), slow acceptance of lease agreements	[50,54,55,67–69]	✓	
		Company culture and a mindset for sustainability or CE value within the company and value chain	[34,54,55,68]	✓	✓
		Risk aversion, inertia or conservatism (internally/across the supply chain). Preference for incremental over radical experimentation and innovation	[34,55,69]	✓	
		Relationship power dynamics and costs, based upon the position within the value chain	[34,67]		✓
Institutional/Regulatory		Legislation, regulations and taxes favouring linear processes	[34,50,54,55,66,67,69]	✓	
		Lack of vision and consensus from governments for CE	[55,67]	✓	
		Limited circular procurement	[55]	✓	

3. Research Design

We adopted an explorative case approach to investigate the motives, drivers and barriers that stimulate or hinder collaborative innovation within the circular economy context. We used multiple cases, with data being collected through desk-based sources from company websites, reports, press releases and other external communications. Primary data was collected through semi-structured interviews [70]. This approach was chosen to ask ‘why’ questions from practice [71]. The purpose of the study was to explore insights into the motives of the interviewees, their respective companies and the different contexts whereby collaborative innovation was pursued. The interview protocol was constructed following recommendations from best practice [70], with interview topics and questions derived from the literature and from previous work [72]. The objective of the study and the unit of analysis was to explore inter-organisational collaborative relationships, their motives and the resulting actions undertaken within the context of CE innovation. We chose to explore case companies selected from the Netherlands, which are considered to be a circular hotspot where COI actions are actively supported. Additionally, the Dutch government has put forward an ambitious target to be ‘fully circular’ by 2050, and it has identified five priority sectors, including biomass and food, plastics, manufacturing, construction, and consumer goods [29,73]. Thus, the Dutch economy offers potential insights from within state-of-the-art practice. We chose to explore front-running CE companies; those who have instigated CE actions within the Netherlands. Case companies were selected based upon a stated circular economy vision, and the external communication of circular product and/or service innovations where collaborations were undertaken. We engaged with a range of sectors and product categories in an attempt to mirror the Dutch government’s priority sectors. We chose this breadth of sample to assess whether the motives for collaboration presented similarities or differences from a broad base of cases. Additionally, the accessibility of key managers who led the development and implementation of COI activities was a contributing criterion. This supported the understanding of the reasoning behind the decisions required to engage with our research question. This resulted in 12 semi-structured interviews ranging between one to two hours, with 11 companies. The key aspects of the case companies and interviewees are presented in Table 5. The interview topics focused on CE concepts, circular strategies and vision, and collaborative circular innovation and motives. Appendix A provides sample questions.

Table 5. Case companies and interview participant.

Case	Length of Interview	Interviewee Position	Industry/Sector	Product Category/Type	No. of Employees
A	1 h 25 min	CSR Consultant, CO ₂ & Circularity	Energy	Infrastructure	>5500
B	1 h	Director of Sustainability	Electronics	Household, consumer, healthcare and lighting products	>70,000
	1 h	Senior Manager Sustainability			
C	1 h 15 min	Circular Economy Manager—Plastic Cycle	FMCG	Food, drink and health products	>100,000
D	1 h	Lead—Global Centre Circular Economy	ICT	Hardware, software and consulting services	>350,000
E	1 h	Supply Chain Manager	Furniture	Beds, mattresses and bedroom accessories	>200
F	1 h 10 min	Director of EMEA Regulations & Standards, Environmental Affairs and Producer Responsibility	ICT	ICT hardware and IT services	>100,000
G	1 h 20 min	Co-founder, Resource Efficiency Manager	Electronics	Smartphone	>75
H	1 h	Circular Economy Specialist and Strategic Consultant	Real Estate	Consulting and development services for sustainable construction	>20
I	1 h 30 min	Circular Economy Manager	Furniture	Office and workspace furniture	>150
J	1 h 45 min	Director of Sustainability	Flooring	Carpet	>350
K	1 h 30 min	Sustainability Marketer	Chemicals	Health, nutrition and materials (plastics and resins)	>21,000

Interviews were transcribed ad verbatim, and subsequently forwarded to interviewees to assess the validity. These were then coded using NVivo software. To answer our research question, and to explore why companies pursue collaborative circular oriented innovation, we looked for the circular economy strategies, evidence of collaborative approaches, and circular oriented innovation activities, and specifically, we explored the motives, drivers and barriers. Coding was initially conducted deductively by using a coding scheme that mirrored the interview topics of circular strategies, collaboration and innovation that were derived from the literature. Inductive coding was followed with additional codes added iteratively, based upon key insights derived from the coding process. A presentation of our iterative codes and their explanations can be found in Appendix B. During the coding process, we actively referred to, created and updated the code definitions to maintain focus upon the codes' meaning, and to ensure that the text was coded accurately. We present in Table 6 a specific example of how we coded 'motives' for circular economy strategies. We also provide an explanation of why the illustrative quotes reflect the example code. The researchers actively interpreted codes through grouping the categories and assessing the findings against the 'hard' and 'soft' dimensions, as shown in Table 2. We compared these to the literature findings presented in Tables 3 and 4. The data derived from practice was then assessed to explore the differences and similarities. Finally, we combined the insights to present a framework that proposes a description of why companies collaborate, based upon our explorative cases. This is subsequently used to support the discussion of the findings.

Table 6. Example code and illustrative quotes from cases.

Example Code	Illustrative Quotes from Cases	Explanation of Why the Quote Illustrates the Code
Circular Economy Strategies Motives	B "It is very important to find people who have internal drivers. Can be business driven or sustainability driven. Find people who have an intrinsic belief with what they want to do. Find your CE champions."	The need to understand people's internal motivations to act towards CE.
	E "Apart from being profitable and delivering value to the business . . . I am here, to be able to make a difference."	Highlights both the personal and organisational reasons to explore CE
	G "It is also really important and linked to the motivation of individuals and how much they are willing to push certain objectives.	Highlights the process of engaging with a person's motives to drive CE. Represents how the intrinsic and extrinsic are important
	K "It is sustainability in general but CE is developing in such a way that, I personally find it fascinating, that if you are just supplying the product you are have only done half of your job."	Presents the personal engagement with CE due to interest/internal excitement to learn and a sense of responsibility
	H "So he (CEO) came to the realisation that if you are building tomorrow's world, as a building/project developer, it should be better than the one we are currently in. Whereby you need to add more than you take out of the system. Otherwise your life has a negative result. If there is a purpose to existence it might just be that you do things better than people did before you or you leave the world with more in it than you took out. You add value."	Presenting personal normative views of responsibility to pursue CE. This also shows how such normative values are involved within the development of the CE vision

4. Results

Through an analysis of our cases, we first present distinct aspects of collaborative COI activities in Section 4.1. In Section 4.2, Tables 7 and 8 summarise the key drivers and barriers that are identified through the case studies, these build upon those identified from the literature presented in Tables 3 and 4.

4.1. Case Findings: Insights into Collaborative Circular Oriented Innovation

4.1.1. Collaborative COI Intensity and Excitement

Collaboration is not unique to COI, but all interviewees discussed from their experience that they see a need for earlier, more intense and wider collaborations than previously, due to the new and systemic nature of COI. Case E stated: "Collaboration becomes increasingly important as you cannot assume that a certain cause of action will take place because that is the way it has always been. But because it is new you have to collaborate and on a larger scale than you have before to make it happen". Case H advances this line of thought by stating "But you see with a linear project you work from chain to chain, link to link to link. Here we try to look at the entire system. So, we try to look at everything at the same time". Another common theme discussed was the excitement of participants to engage and go beyond existing roles. Case A stated: "People are more thrilled, and their ideas open up. The peaks are higher and the valleys are lower. So, in a normal collaboration, people tend to stick to their roles . . . I have to say only some got excited about it as others also see and realise how complex it is". This was echoed by Case F who stated: "the level of excitement is generally higher. So, when people realise that they are working on cutting edge stuff that benefits the environment. They get excited. Because it is something new, you need to think more, put more things in and it is more complex". Yet, interviewees argued that this sense of excitement should only be needed currently to mitigate the current barriers, complexity, and the linear mindset. However, there was a common recognition for the need to find partners who are willing and excited to do COI, regardless of the complexity. Here, a key factor is the current premature state of COI, resulting in the fact that actors that are involved need to be more open and creative.

4.1.2. Basis for Collaboration, Partner Selection and Balancing Informal Processes

Another key difference presented by our cases is the basis for collaborative COI. This is commonly instigated either by an identified problem that generates a sense of responsibility, or by an existing proof of CE that inspires actors to develop a CE vision and engage with COI. Our cases indicated that this impacts decisions with regards to partner selection. Most interviewees indicated that when engaging externally, they started discussions with their vision. This is most clearly presented by Case C who said: “once I set my vision and what I want to achieve then whatever challenges I can face for me to achieve my vision I can look for partners that can help me . . . So when starting those initial discussions it is the vision that you lead on to get enthusiasm and engagement”. Case E was more explicit with regards the role of a CE vision for partner selection by stating: “If you can find each other in that future vision then everything else is relatively easy. If you only talk price, then everything else is relatively difficult”. Yet, Case I highlights how such a partner selection process is not optimal and presents: “a messy approach and is sometime based more on a gut feeling, a good place/person to work with to achieve the aim. But business-wise it is sometimes difficult to explain to the CEO or a colleague. I find it difficult due to the types of parameters to choose from, this is the struggle I have”. Furthermore, a common theme within the partner selection process discussed by the cases was how such discussions are linked to the need to develop levels of trust. This initially can be an informal process, but levels of trust also affect the management of collaborative COI projects. This presents a challenge for the actors who engage with COI, as they need to balance the formal and informal processes with challenges remaining around how to do so. Case G highlights how: “there are lots of informal chats. I would pretty much say we are friends also. So there are a lot of conversations when we need something from each other. I think a lot of things just come by”. Adding to this, most cases explicitly mentioned that collaborative contracting is challenging and impacts COI, with Case D stating: “how do we build a contract to four to five parties together, while we are all providing services to each other. So we are still trying to work out how to do that”. A key distinction that was raised is whether the collaboration represents a competitive process or not, and generates core intellectual property, technology or commercial outputs, which would impede collaboration and contracting processes.

4.1.3. Systemic, Connected and Collaborative Innovation

The type, depth, radical nature and connections between innovations were raised as another key element that is different within the collaborative COI activities. Interviewees commented that when starting COI activities, collaborators’ initial interpretations of the challenges are focussed upon material throughput, but they can quickly assess deeper complexities. This raises the need for deeper engagement across the supply chain, as presented by Case A, who stated: “first we had the core group, we had sessions where we went all through the supply chains for the first time. We had on (sic) the same table the designers, us as owners and the waste treatment guys. This really opened the (sic) eyes. The material recovery participants came along with an old product and put it on the table and asked what do you expect me to do with this? How do I get to the pure materials? . . . So that type of conversation was illuminating and really helped”.

Additionally, the connection between the product design and business model was a theme raised by all interviewees, as shown by Case E who stated: “naturally if you look into B2B and not giving up ownership and also adding services upon the product you are delivering to move towards a service model. Then you have to change the design of your product completely. It is a totally different approach”. Furthermore, the learning style presented by all parties was through a process of learning as you go via collaborative experimentation and piloting ideas with on-boarding clients. Case I highlights this: “We have learnt a lot from the refurbishing of all kinds of products. The next step is I think the business model. We also know how the business model links with the design. If you want to change the whole design then it could be more expensive. Then you have to go to your customer and ask if this is what you want to pay or whether they want a reused or more sustainable product.

So every step we take you need to engage with and get along with someone else". The integrated nature of the innovation actions and associated challenges that this brings was a common theme.

4.2. Collaborative Circular Oriented Innovation Drivers and Barriers

Analysis of our cases is conducted along the 'hard' and 'soft' dimensions, with focus being drawn to COI and collaboration to present the CE drivers (Table 7) and CE barriers (Table 8).

Table 7. COI drivers assessed within case studies (findings relating to circular oriented innovation (1) and collaboration (2)).

		Drivers	Case	Relates to	
				1	2
Hard					
Technical		Increasing proofs of concept, stimulating others actions to test assumptions, experiment and pilot at scale	A/B/D/E/F/I/J	✓	
		Accomplishing product improvements generated by CE innovation	A/B/D/E/I/K	✓	
		Increasing material specifications, the exploration of new or altered functional needs for materials within CE innovation	B/C/F/G/H		✓
		Cross-sectoral or common societal challenges, e.g., ocean plastic	C/F/J	✓	✓
		CE expertise outside core operations, e.g., CE recovery strategies or reverse logistics	C/D/G		✓
Market		Innovation potential and the development of CE strategic capabilities and the knowledge for CBM	All	✓	
		Anticipation of financial return, new business opportunities and efficiency savings within circular strategies	All	✓	
		Access to new market: sales channels, customers (B2B + B2C) or to forward or reverse integrate product offerings (B2B)	E/G/I/J/K	✓	
		Pursuit of CE-oriented tendering or procurement processes	A/I	✓	
Soft					
Social/Cultural		Enthusiasm and desire to be a CE front-runner to develop new knowledge, attract talent and to realise personal and company motivations	All	✓	
		Growing sense of urgency and need for networked innovation to develop CE/sustainable transitions: linked to increasingly internal sustainable decision models and processes	All	✓	✓
		Search for and/or creation of credibility and acceptance via CE networks: Aim to find active companies pursuing CE to collaborate with	B/D/E/F/J/H/I	✓	
		Increasing demands from customers (B2B) for sustainable products and experience	E/I	✓	
Institutional/Regulatory		Increasing lobbying for CE legislation	A/C/E/H/J	✓	
		Need for/awareness of creation and the acceptance of cross-industry standards	D/H/K		✓

Table 8. COI Barriers assessed within case studies (findings relating to circular oriented innovation (1) and collaboration (2)).

		Barriers	Case	Relates to	
				1	2
Hard					
Technical		Lack of technical knowledge/skills for CE: Current linear dynamics, training and skills stopping CE development	A/B/C/D/E/F/H/I/J	✓	
		Legacy of linear products/material challenge identification for secondary materials	A/B/D/E/F/H/I/J	✓	✓
		Sourcing materials: quantity, quality, fairly/environmentally produced for both virgin or recovered	A/B/C/F/G/H	✓	
		Complexity to integrate CE knowledge	A/H/I/J		✓
		Sectorial differences in the specification and the variation of material requirements: impacting selection and reuse options	B/F/H/J	✓	
		Position and power within the regional vs global supply network, and pre-existing contracts and distribution, creating lock-in	F/G/K		✓
		Alignment of skills, capabilities and resources to collaborate effectively	A/D/H		✓

Table 8. Cont.

		Barriers	Case	Relates to	
				1	2
Hard					
Market		Financial assessment and accounting based on linear concepts of rapid returns vs longer-term returns—CBMs challenged by short-term profitability or generating split incentives	A/B/C/D/E/H/J/K	✓	✓
		Contracting for collaborative actions to align incentives, risk vs reward across the value chain	A/B/D/E/G/H/J/K		✓
		Balance formal vs informal. Flexibility and adaptability within contracting and project management procedures	A/B/G/H/J		✓
		Reverse logistics costs for closed loops + low virgin material and product prices, creating unfair competition	B/C/F/J	✓	
		Higher administrative costs and investment required. e.g., time, money and resources to collaborate	A/B/H/I		✓
Soft					
Social/Cultural		Balancing company culture, mindset and sustainable value internally or externally, for opening up to create the right environment for collaboration.	A/B/E/F/H/J/K		✓
		Trust and transparency of information flows, motivations and goals to collaborate freely with partners—especially pre-competitive vs competitive collaboration with regards to knowledge sharing	A/B/F/G/H/J		✓
		Finding and selecting partners—how, where and who to start collaborations with that are feasible and scalable	A/D/E/H/I/J		✓
		Demand side (B2C) limited perception, education, the desire or access to information for sustainable or circular BMs	B/C/H/J/K	✓	
		Lack of desire, fear of change or blocking activities by supply chain members to maintain the linear status quo or the preference for incremental changes	A/C/H/J/K		✓
		Lack of a common language across sectors/life cycle stages	A/B/D/E/I		✓
		Generating sufficient commitment to CE collaborative innovation	B/H/J/K		✓
		Common/shared understanding for CE vision across collaborating partners and internal motivations	A/B/J		✓
Institutional/Regulatory		Lack of certifications, standards, taxes regulation across life-cycle stages	A/D/H/J	✓	

5. Discussion

Our research set out to explore why companies collaborate within COI. Through combining our literature and case analysis, we propose a framework that distinguishes such motives across different levels, as depicted in Figure 2. Here, we show multiple intrinsic motives (activities that are pursued for their own sake) and extrinsic motives (activities that earn external rewards or avoid punishment) [74], which originate from both the personal and organisational levels. These manifest from the norms and values of the actors and the CE system context. An example is the growing sense of responsibility for sustainability, which can be both a personal and organisational intrinsic motive, and presents a feeling that pursuing sustainability is the right thing to do, but it can also lead to extrinsic motivations, such as external recognition. Such motives act as a trigger to collaborate with others, if the actors feel alignment between their motivations. Other triggers that motivate collaboration result from the identified tactical and operational requirements that are derived from the COI strategy. These motives are the increased focus upon resources, and the need to find suitable contexts to experiment and mitigate the complexity of operationalising circular business models throughout the value chain and across life-cycle phases. The awareness of interdependences, resulting from the problem complexity and the distribution of knowledge drives this process, as well as the combinations of intrinsic and extrinsic motives, such as the motivation to secure supplies of materials, develop CE innovation capabilities, competencies, or gain recognition externally.

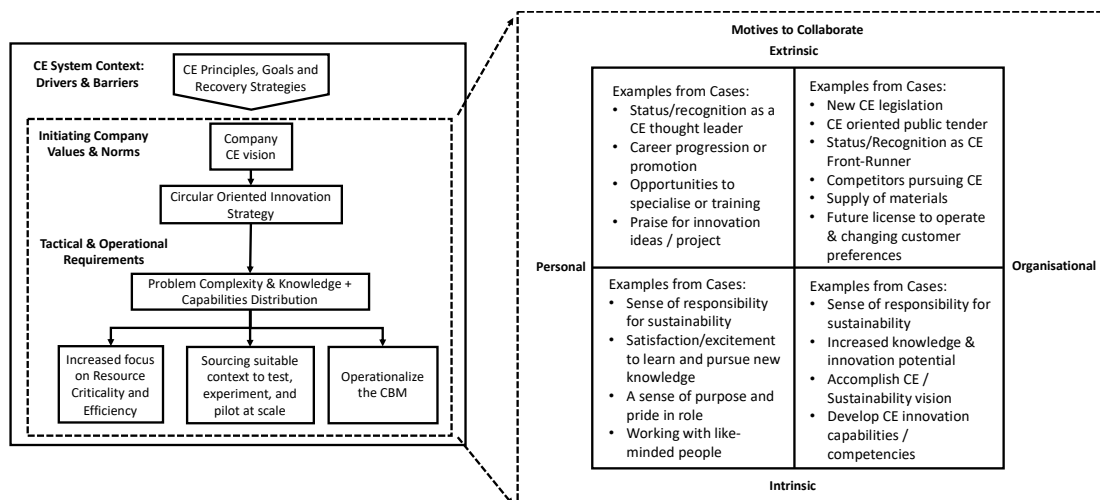


Figure 2. Motives to collaborate within circular oriented innovation.

The remainder of the discussion is structured, following this framework to highlight crucial insights, and to answer our question with regards to what motives, drivers and barriers are present in relation to collaborative COI.

5.1. Personal Motives of Actors to Collaborate

The combination of intrinsic and extrinsic motives goes beyond purely economic drivers towards normative values for sustainability, a sense of responsibility and desired recognition. The actors themselves and their characteristics are therefore important factors for understanding why collaborations develop. The case studies indicated that personal enthusiasm and perseverance are needed to face obstacles within the COI process. Additionally, our cases highlighted a need for collaborative actors and organisations to have the right mind-set and motivations to pursue CE, which can also act as a key motive to collaborate. This is due to many collaborations being built via relational means, whereby participants had met at a specific event or already knew each other. Through developing a feeling of alignment between their organisation’s future visions and themselves, as direct potential collaborators, the actors can decide to explore CE challenges together, initially on a small-scale, but with active participation and gradual proofs of shared alignment, the collaborative relationship and activities can deepen. The potential for such personal connections to result in collaborations is increased by the assessment of complimentary culture, capabilities, CE approach and suitable position within the value network. Thus, active participation by actors involved within the development of the CE vision or COI strategy in specific CE networks facilitates data gathering. In addition, this also supports partner selection, and can motivate potential collaborations through inspiration or identification of opportunities. Yet, we find that this requires discussions to be at the appropriate strategic level, usually between directors, who hold credibility and decision-making power.

Capabilities of Actors to Build and Support Collaboration

The central role of actors involved and their ability to drive innovation is well-established and researched within the innovation literature [42,75]. Our cases expand upon this central role of the entrepreneurial actors and their traits by showing that abilities to build trust, credibility and envision COI opportunities supports collaborations. These capabilities also play a role within the challenge to create and maintain the right environment for collaborations to flourish. Here, all partners need to recognise the benefits quickly, which requires active leadership in order to develop early gains and to highlight internally, and across the collaborative partners, the increased value of inflows of knowledge produced via collaboration [12,76,77]. Building upon literature that focuses upon entrepreneurs and intrapreneurs, we assume that effectuation [78,79] and the role of champions within innovation holds

the potential for additional insights. This would add further understanding into why and how such personal enthusiasm and skills are translated into the way companies develop their CE vision and collaborative COI strategies. The challenge is whether such insights can result in formalised processes, or whether experience, characteristics and the traits of the actors are central and inseparable from the collaborative COI activities. Additionally, an understanding is needed on the differences between, on the one hand, the actors involved, and on the other, their motives to support collaborations and to maintain commitment (both personally and at the organisational level).

5.2. Drivers and Barriers for CE Vision and the COI Strategy

The current system context, combined with the circular principles, goals, and recovery strategies guides front-running companies to develop their CE vision. This is translated into COI strategies that shows how radical and open the company culture is, and reflects their goals and interpretation of the CE challenge. Our cases show that increasingly, within CE front-running companies, the CE vision is being translated into circular oriented corporate policies. These signals both the intrinsic and extrinsic motives to employees and potential collaborative partners for why CE is undertaken, and supports the proposed centrality of a CE vision for developing collaborative COI actions [35,72]. This also aligns with Dangelico and Purjari [31], who found that translating the core vision into strategy and policy is needed for success, but that this effect goes deeper within collaborative COI activities. Cases (A/B/C/E/I/J) directly stated that aligning and sharing future visions with potential collaborative partners early, acts as a marker for partner selection. This tests the viability and credibility of the partners, beyond interdisciplinary competencies. The indication is that alignment is needed at the level of values and norms, as well as 'hard' capabilities. However, some cases (B/D/I/G/K) also highlighted that collaborators' motives to engage with CE can also be driven by the fear of missing out or of losing existing or future competitiveness. It is unclear whether these differing motives affect the collaborative process for COI. However, it is clear that presenting a culture for innovation-oriented learning and critical reflective analysis of actions is a crucial condition. Cases (A/B/C/E/F/I/J) specifically mentioned that the company culture, CE maturity level, and their ability to consistently co-create a learning environment, whilst displaying flexibility and adaptability for decision making, were decisive factors, which supports De Mederios et al.'s [14] findings. If such a CE vision and 'soft' cultural alignments are met, these can translate into a motive to collaborate. We propose that future research is needed within COI to explore whether these specific conditions interact to affect collaborations or the COI process.

5.2.1. Drivers and Barriers for COI the Increasing Focus upon Resources

The first tactical and operational determined motive to collaborate, as shown by all our cases, is the increasing focus upon resources within COI. This commonly leads to the first collaborative step, which implies THE collection of data for materials, products or supply chain operations. These activities identify potential hotspots, common risks, critical leverage points and technical barriers. The increased need for data triggers early collaboration within COI processes. This aligns with Adams et al. [10], who signify that co-developing the problem and solution space is a crucial motive for developing collaborations. The drive for data created some new collaborative arrangements within our cases, although mostly these were conducted between existing suppliers, known experts or previous collaborators. While some cases (B/D/E/F/H) indicated an increase in exploring multi-sector collaborations driven by common challenges around materials, the requirements for new supply and demand side data, or societal challenges such as ocean plastics. The motive to collaboratively gather data is linked to the need to understand the system, such as global supply chains, differences across sectors, and the scale of regional/local collection and processing to support CE recovery strategies. The data is also needed to assess the feasibility for reuse of materials, logistics and COI potential system impacts. Furthermore, collaboration was cited as being required earlier within the design process for new CE products and services. Cases stated a need to get the designer, manufacturer and

material recovery experts together to maximise potential material recovery opportunities. Where new products were developed, they combined a focus on materials and alternative business models, with cases (A/B/E/I/K) for realising product improvements through such collaborative COI actions. The majority of these material-focused collaborations explored closed-loops or product-service-system combinations. Deviating from Adams et al. [10] proposed 'system builder', the developed innovations are not yet radically different, but they rather represent incremental improvements via material selection or substitution ratios of recycled content. Yet, we identify that increasingly radical shifts in the way in which business is conducted, based upon motives for material criticality, reuse potential and supply chain impacts, are beginning, as represented by cases (D/E/G/I) who explored new knowledge in the form of material passporting and the exploration of current value opportunities within material reuse or reduction. Further research is required to assess whether this increased focus upon resources is a first step that results in radically new collaborative value constellations, as per Adams et al.'s [10] proposed 'system builder'.

5.2.2. Drivers and Barriers for COI Finding a Suitable Context to Test, Experiment and Pilot at Scale

The second tactical and operational motive identified to collaborate is the need for finding a suitable context to experiment. This allows for the reduction of the complexity of the potential systems approach into manageable projects. The suitability of a context is determined by the physical space of the product or service that is identified to experiment upon, but it also incorporates engaging the 'right' mix of partners with the minimal levels of knowledge, capabilities, infrastructure, credibility, and trust that is required to conduct fast learning cycles. This is dependent upon the type and purpose of the experiment to be conducted. Recent work by Bocken et al. [56] identifies that motives for experimentation can be used to explore value propositions, delivery, creation, capture and field experiments, which companies can iterate between. Beyond the knowledge creation that experimentation brings, it also supports deeper engagement with other stakeholders to develop proofs of concept that can overcome internal resistance to the potential CE transition. Collaborative experimentation also ultimately allows partners to see whether they work well together, and whether their skills, culture, mindset and vision are truly aligned. A key challenge within finding suitable contexts to experiment is also the need to test at scale, to allow unintended or unexpected system impacts such as logistics, storage, or other operational challenges to emerge. Here, collaboration is crucial to reach such a scale, and also allows the risks and costs to be shared. This opens new research areas with regard to understanding the different ways by which to select suitable contexts, strategies and methods to separate systemic challenges into smaller, testable and lean experimentation processes.

5.2.3. Drivers and Barriers for COI to Operationalise the Circular Business Model

The third tactical and operational motive, and arguably within our cases, the least developed, are collaborative pursuits that operationalise the business model. This finding seems to confirm the statement of Adams et al. [10] that 'system builders' are not yet widespread. Here, our cases show a key split between technical innovation on the one hand, and market and business model innovation on the other. Case (B) described this split as being directed by the level of maturity of the various activities, with the business model being less mature and challenging. However, this represents potentially greater rewards if solutions are found. The lower level of collaboration is paradoxically observed where increased collaboration is required to develop all of the operations needed to operationalise CE recovery strategies that aid CE business models. However, this is also the area where competition increases, which reduces tendencies to be open and collaborative. This is reminiscent of the open innovation paradox identified by Bogers [76], whereby firms share, but also simultaneously want to protect knowledge. Case (J) took this further by indicating that collaboration becomes increasingly challenging when it comes to sharing economic rewards, which is often needed for circular business model innovation [25]. This is due to the predominant mindset to maximise one's own returns, rather

than assessing the potential increase for the whole operation. This directly reflects a ‘soft’ cultural barrier for advancing COI collaborations beyond the experimentation phase towards the competitive.

The ‘soft’ factors that represent the company culture and abilities to collaborate effectively can be described as a higher-order challenge. Without a suitable culture and mindset within and across the organisations involved, the shared CE vision and value proposition will not develop. Our finding aligns with Kirchherr et al. [55], who indicate that changing corporate culture is the highest challenge for a company. This, we speculate, creates a causality issue and tension between maximising one’s own profits and sharing rewards to increase the successful pursuit of collaborative COI activities to develop radically new products, business models and value constellations. The challenge is how to increase internal motivations to change the company culture without first achieving early wins and proof of CE concepts. Here, the actors driving collaborative COI activities need to be astute to the motives of collaborative actors (depicted in Figure 2) to navigate potential barriers and to maintain enthusiasm. As noted by Kirchherr et al. [55], our results show that such bursts of enthusiasm are accelerating experimentation. These experiments are needed to develop clear answers and examples of ways to capture and assess circular value, to create further motives for companies to advance their CE agenda. We argue this is required, as cases (B/D/F/J/H/G) indicated that collaborations have thus far been challenged by transitioning to the competitive. Cases (D/H/G) expand upon this by stating that the challenge is around what is valued, and how to overcome the current linear mindsets to support COI. This builds upon the challenge of collaborative finance and contracting that was previously raised by Fischer and Pascucci [66] and Rizos et al. [54], as we highlight the essential ‘soft’ barriers of the company culture and mindsets that need to be overcome. Building on this, future research into how organisations can collaboratively create value propositions and contracting structures will support such collaborations to move beyond the current experimentation phase towards functioning systemic-level business models. Otherwise, the creation of novel new value configurations will be limited, challenging Adams et al.’s [10] proposed ‘system builder’.

The Dutch government aims to support the advancement of these tensions between ‘hard’ and ‘soft’ drivers and barriers for COI by motivating companies through policy and stimulating B2B demand through competitive circular oriented tenders (so-called Green Deals [29,73]). The Green Deals reduce certain legal demands on government purchasing, and require collaborative experimentation within the initial phase of successful tenders (Case A/I). Such formalised structures are designed to initiate collaborations and is a further motive for why companies collaborate. Case (I) indicates that, “our current success rate has been 8 out of 10 for the circular tenders that have come out”. Such tenders also challenge the organisation to solve operational challenges, such as issues of contracting or logistics. This shows that the capabilities to successfully develop collaborative CE innovation are starting to become a clear economic driver, aligning with findings from Rizos et al. [54]. This also aligns with proposals from Curley and Salmelin [53] that COI policies stimulated by government involvement via the triple (or quadruple) helix support, can stimulate new markets and create win–win situations that kick-start COI ecosystems. Cases (A/C/E/H/J) also indicate there is an increasing collaborative lobbying and consultation process happening with the Dutch and EU governments to explore ‘soft’ legislation and system barriers to further stimulate COI opportunities.

5.3. Proposed Conditions and Motives for Collaborative Circular Oriented Innovation

Inferring from the literature and case findings, we describe the initial conditions and motives (placed where they most commonly occur) that lead to collaborative COI, as shown in Figure 3. This starts with the identification of a current system failure or a shared problem, which inspires an entrepreneurial oriented CE champion. Due to the awareness of interdependencies, the CE champion actively engages with other CE innovation-oriented learning by presenting an initial CE vision, and proposes collaborative COI strategies. Initially, this is to engage the minimum viable capabilities and resources that are suitable for experiment. Thus, pursuing the motive for new knowledge results

in collaborative groups who aim to overcome the ‘hard’ and ‘soft’ barriers. The ultimate intention is to operationalise COI, although, based on our cases, this is still rare.

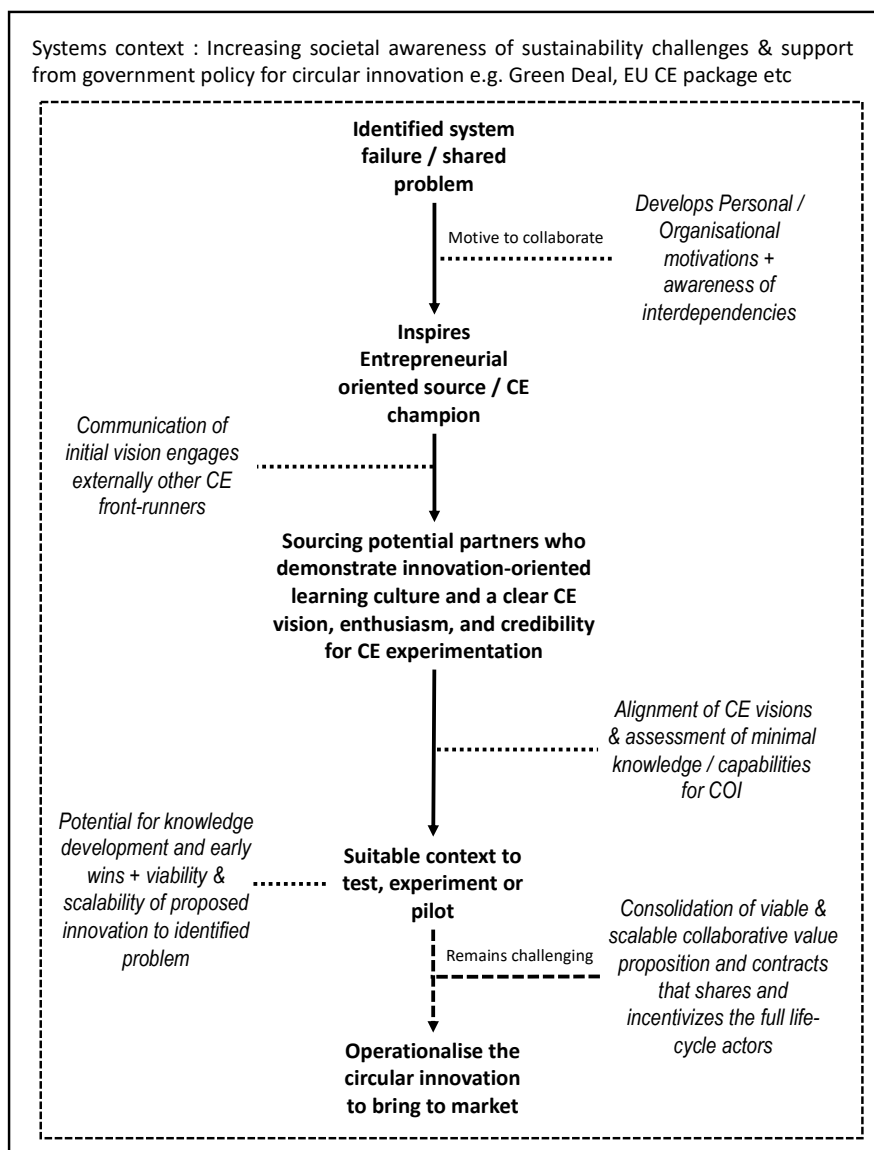


Figure 3. Proposed conditions and motives for collaborative circular oriented innovation.

6. Conclusions

Our study has shown how circular oriented innovation is positioned upon an expanding, increasingly complex, and radically sustainable oriented innovation continuum. Circular oriented innovation takes place at the systemic level, to gain the biggest potential sustainability impact. We define COI as the coordinated activities that integrate CE goals, principles and recovery strategies into technical and market-based innovations, such that the circular products and services that are brought to market purposefully maintain product integrity and value capture potential across the full life-cycle.

We have shown that collaboration is increasingly engaged earlier and deeper and built upon relational elements that incorporate normative and value-driven motives to collaborate. Within circular oriented innovation, these motives originate from both the individual and organisational levels, and represent intrinsic and extrinsic motivations. These motives are manifest through the CE vision, COI strategies and the technical and operational challenges that these create. Further research through

longitudinal case studies is required to test if the motives, conditions and stages we identified are accurate, or whether potential iterations and feedback loops are exhibited. Furthermore, it is important to test the accuracy of our findings in relation to specific product categories, sectors or CE challenges.

Our study shows that excitement for CE and the ambition to become a CE front-runners is driving the co-creation of the problem and solution space to develop insights, best practices and guidance through fast-cycle collaborative experimentation and the validation of underlying assumptions. Collaborative partners are being sourced by entrepreneurially minded leadership, motivated by enthusiasm, and crucially, a credible approach to CE. Such collaborating groups actively aim to overcome the 'hard' and 'soft' barriers to COI, to create the right environment and culture to collaborate effectively. This has two added benefits: one, it raises the reputation and credibility of those involved, which is a key motivation, and two, it incentivises others to follow proofs of concepts. Such collaborative experimentations test the current pre-paradigmatic status of CE. However, these collaborations are still largely challenged by moving to the competitive.

Based upon our cases and the literature studied, circular oriented innovation currently faces the challenge to move from the level of new market opportunities and closed-loop exploration to the generation of societal changes, through novel larger-scale collaborations. This requires increased attention towards 'soft' barriers, to change organisational mindsets to facilitate collaborative knowledge development and sharing, the creation of shared visions, and collaborative value propositions.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Interview Topics and Sample Questions

Interview Topics	Sample Questions
CE introduction	What does the term circular economy mean to you?
CE Collaborative Innovation	<p>Who or which organisation(s) were involved within the initial collaboration?</p> <p>Did this evolve over time?</p> <p>Why and how did this happen?</p> <p>How long were collaborative activities undertaken, and why did they develop?</p> <p>Who or which organisation did you collaborate most closely with to deliver the circular strategy? Please describe why and how you engaged with them.</p> <p>How would you describe the benefits/challenges you (and/or your organisation) experienced within the collaborative process?</p> <p>What were the results that you (and/or your organisation) experienced through the collaborative processes?</p> <p>Can you discuss any specific differences experienced between the collaborative processes when pursuing circular strategies in comparison with linear/traditional?</p> <p>If in the future (15–20 years) CE is a more standard operation, do you think that collaboration between companies will be different at this point?</p>
Circular Strategies and Vision	<p>What impact has the circular vision had upon your: role or department and organisation?</p> <p>Were there any specific skills, capabilities or knowledge missing to complete the required work, and if so, how were these overcome?</p> <p>Were there differences experienced compared to non-circular strategy-led projects?</p>

Appendix B. Iterative Codes Developed, and Explanation

Initial Code	Iterative Codes	Code Explanation
Circular Economy Strategies	Motives	Specific intrinsic and extrinsic (personal/organisational) reasons to explore or act
	Vision/Strategy	What the company or individual anticipates or plans, and how they respond to CE recovery strategies
	CE vs. Linear	Direct differences that are discussed in relation to motives, drivers/barriers and actions
	Drivers and Barriers	Hard/soft—in relation to CE concept, vision or strategy and motives
Collaboration	Vision	Specific role of vision within the collaborative process discussed
	Motives	Specific intrinsic and extrinsic (personal/organisational) reasons to explore or act
	Trust	Commitment, credibility or trust between collaborators is discussed
	Partner selection	Process, reasons and actions for partner selection are discussed
	Formal vs. Informal Project Management	Discussion of different ways of project/relationship management to support and enable collaboration
	Collaboration vs. Competition	Instances of tensions discussed: collaborating with competitors, pre-competitive/competition or commercial gain
	Drivers and Barriers	Hard/soft—in relation to collaborative vision, motives, and strategy
Circular Oriented Innovation	Business Model	Discussion of experimentation with or development of value proposition, creation, delivery or capture
	Network/Supply chain	Discussion of network or supply chain actions, skills or capabilities
	Design	Explicit design changes, methods or actions are mentioned
	Drivers and Barriers	Hard/soft—in relation to innovation actions or strategy

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