

Critical features of ecosystem practice empowering industrial sustainability transformation

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Abstract

The pursuit of a sustainable industry is facilitated by the evolution of diverse cooperative networks. There is a limited understanding of how industrial actors can collectively foster the continuity in learning required to address wicked problems of sustainability. This study explores how industry stakeholders collectively address this wicked problem by fostering innovation in ecosystems and identifies the critical features of an ecosystem practice that supports empowerment in evolving multi-actor network settings. Employing an abductive approach, we integrate insights from the innovation literature with analyses of three empirical industrial ecosystem cases to enhance understanding of the internal dynamics inherent in collaborative innovation. This study elucidates the critical features of ecosystem practice, underscoring four key characteristics essential for empowerment. These characteristics hinge on the adept balance of the four identified critical features throughout the process of continuous innovating in ecosystems. We argue that such practices serve as catalysts for cross-industry innovation, thus expediting transformation. This research contributes to understanding the self-organizing dynamics needed for sustained learning in evolving collaboration settings where actors, their motivations and their roles change. It also advances innovation theory by illustrating how wicked problems can be collectively addressed through the continuous exploration and exploitation processes of ecosystems.

KEYWORDS

business ecosystem, collaboration; sustained learning, innovation, practice, self-organization, sustainability, wicked problem

1 | INTRODUCTION

Innovation research concepts and approaches are challenged by industrial sustainability problems. This sustainability challenge has reinforced the notion that solely understanding collaborative innovation from the perspective of individual firms' motives is insufficient. Research should also embrace a more systemic and dynamic form

of innovation collaboration within evolving networks, often called ecosystems. This evolving nature means that actors, their roles and their motivations change over time (Paasi et al., 2023). Industrial sustainability can be construed as the outcome of a transformative process in which the industrial sectors actively contribute to a socially, environmentally and economically sustainable global environment. This involves catalysing, planning and executing necessary changes

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through a transformative trajectory (Tonelli et al., 2013) that highlights the need for continuity in innovation through a synergistic combination of exploratory and exploitative activities (Boer & Gertsen, 2003; Lianto et al., 2018; Martini et al., 2013) but in the ecosystem setting (Visscher et al., 2021).

Sustainability, in this context, transcends problem-solving for individual challenges and instead encompasses a holistic transformation of industry, posing intricate and multifaceted problems beyond the capabilities of any single actor. They can be called wicked problems since there is no definite formulation of such problems or solutions (Rittel & Webber, 1973). Accelerating this transformation by empowering industrial players provides an overall motivation for our study. Empowerment, understood here as defined in psychological studies as 'a subjective, cognitive and attitudinal process that helps individuals feel effective, competent and authorized to carry out tasks' (p. 1), is supported by having access to information, resources and support as well as opportunities for innovation and learning (Llorente-Alonso et al., 2023). Collaboration in ecosystems can provide opportunities for these and promote a feeling of capability, enabling individuals to contribute effectively to tackling complex sustainability-related issues. Reaching threefold sustainability in industries requires these *wicked problems* to be addressed through networked innovation power to push the boundaries of understanding (Dahlander et al., 2021) on which cross-industry links can provide a diversity of perspectives needed for renewal (Kääriäinen, Valkokari et al., 2023). Addressing grand challenges, such as sustainability, requires coordinated, collaborative endeavours (George et al., 2016) and a means to foster hope and progress during the protracted process of tackling significant issues (Bogers et al., 2020). This highlights the pivotal role of open co-innovation and ecosystems at the nexus of these efforts (Bogers, 2011; Dahlander et al., 2021). Achieving coordinated efforts in evolving collaboration settings that empower industrial players to address the wicked problem of sustainability remains a pressing concern.

While previous studies have delved into the conceptual aspects and dynamics of ecosystems and have discussed factors contributing to their success (Cobben et al., 2023; Paasi et al., 2023; Phillips & Ritala, 2019; Speich & Ulli-Beer, 2023), a limited understanding of how actors within the ecosystem can collectively foster the continuity in learning required to address wicked problems through networked collaboration remains. The lack of established routines and capabilities for organizing ecosystems for innovation is a pivotal challenge in the current business environment (Linde et al., 2021). We can build on a view that both forms and constitutes collaborative innovations (Cirella & Murphy, 2022; Russo-Spena et al., 2017; Yström & Agogué, 2020) to understand joint learning in ecosystems, which can generate 'a knowledgeable collective action that forges relations and connections among all the resources available and all the constraints present', a practice seen from the inside (S. Gherardi, 2009, p. 117). The inherent complexity of wicked problems necessitates further investigation into the internal dynamics of collaborative innovation and the incorporation of knowledge into business practices in evolving ecosystems as facilitators of transformation.

Thus, to advance our understanding of this recognized gap, we explore internal dynamics that enable continuity in learning needed for progress in sustainability in a multi-actor network approached as an ecosystem practice. In this context, an ecosystem practice refers to knowledgeable collective action that integrates resources and feeds continuous processes of collaborative learning. This type of learning is regarded as necessary for industrial renewal among ecosystem partners (Nuutinen et al., 2024), which are defined as 'an economic community supported by a foundation of interacting organizations and individuals' (Moore, 1996). To understand internal dynamics, we adopt an ongoing and dynamic process view on innovation, in which 'innovating' refers to 'a system of ongoing activities, emerging from actors in networking and socializing' (Russo-Spena et al., 2017, p. 3).

The primary objective of this study is to advance our understanding of the internal dynamics of collaborative innovation in relation to sustainability challenges for theoretical and practical purposes. In this study, our core research question is as follows: What are the critical features of an ecosystem practice that empowers industrial sustainability transformation through continuous innovating?

This study employs an abductive approach, analysing three empirical industrial ecosystem cases within a framework constructed from the existing literature. These cases exemplify industries grappling with significant sustainability challenges: the construction industry and its impact on resource depletion and greenhouse gas emissions, the manufacturing industry with its sustainability burdens (Ilea & Unep, 2018; Nuutinen et al., 2022; Vosman et al., 2023), and the forest industry facing structural shifts driven by societal sustainability goals (Näyhä, 2019). In all cases, the information and communication technology (ICT) sector is represented because its role extends beyond its own operations, as it empowers other industries to embrace sustainability (Zhang et al., 2022). While the challenges vary, this study explores critical features of ecosystem practices to identify those that are suitable for them all and are thus also a starting point for cross-industry collaborative learning to expedite transformation.

The main theoretical contribution is thus intended to expand the view of innovation studies from the strategies of one organisation (Adner, 2017; Lianto et al., 2018) to continuous but dynamic innovating in the changing multi-actor setting conceptualized as an ecosystem practice whose goal is highlighted in the challenge of sustainable development. Sustainability research is a vast and rapidly evolving field at the crossroads of numerous research areas. Although this study initiates its exploration from the perspective of sustainability challenges, its primary objective is not to directly address these challenges.

We start by briefly crafting a theoretical framework based on the literature, detailing the tentative conceptual framework utilized in the empirical analysis and describing the methodological approach. The empirical findings are then summarized and discussed. The theoretical contribution is summarized as a revised framework with theoretical implications, managerial implications and limitations to conclude the paper.

2 | A THEORETICAL FRAMEWORK FOR CRITICAL FEATURES OF ECOSYSTEM PRACTICE

Our formulation of theoretical premises for critical features of an ecosystem practice that can empower sustainability transformation commenced with ecosystem dynamics to understand their nature as facilitators of transformation. We further explore the exploration and exploitation as a central mechanism to understand the incorporation of new knowledge into business practices. To more deeply understand the internal dynamics of collaborative innovation in ecosystems, we elaborate on practice-based grounding for the theoretical framework.

2.1 | Ecosystem dynamics and organizing mechanism

Ecosystem studies involve exploring how businesses actively contribute to sustainability and how industrial players adapt to shifts in the industrial landscape driven by sustainability trends (Liu & Stephens, 2019; Speich & Ulli-Beer, 2023). The ecosystem literature has particularly focused on inter-firm connections and the self-organizing and evolving nature of collaboration, promising to tackle the wicked problem of sustainability (Dahlander et al., 2021; George et al., 2016). As ecosystems are not limited to sectoral boundaries, they provide a means to extend to cross-industry collaboration (Vosman et al., 2023).

The dynamics of collaborative innovation (Dahlander et al., 2021) and ecosystems (Cobben et al., 2022; Gölgeci et al., 2021), such as the emergence and evolution of ecosystems (Polese et al., 2021; Shipilov & Gawer, 2020), have been increasingly studied. Since Moore's opening (Moore, 1993), the ecosystem perspective has gradually gained a firm foothold in the innovation discussion.

Ecosystems involve interconnected companies collaborating to innovate and commercialize solutions for end customers (Jacobides et al., 2018). Unlike business ecosystems, innovation ecosystems are closely tied to their capacity for exploring and integrating new knowledge (Valkokari, 2015). Thus, following Moore's (2006, p. 56) definition of ecosystem co-evolution, our notion is that innovating is also present in business ecosystems: 'In Business Ecosystems, the ideal is perfect co-evolution of innovation across a multitude of contributors.' In their current summary of the ecosystem co-evolution perspective, Hou and Shi (2021) noted that co-evolution refers to a process through which the properties of organisations become increasingly complementary (Moore, 1993). Reaching a better value for the end customer with an ecosystem of complementary organizations might not be enough to significantly impact sustainability development, even though sustainability awareness is increasing. This literature points out that coevolutionary dynamics can occur not only within an ecosystem but also between an ecosystem and its environment. Therefore, the co-evolution view has been used loosely or implicitly at a descriptive level and has generated few insights and mechanisms

(Jacobides et al., 2018; Thomas & Autio, 2020). Meynhardt et al. (2016) defined systemic principles related to the complexity and dynamics of ecosystem evolution. According to their proposed conceptualization, the system might be destabilized to a point where elements can 'break free' of an 'old order', and a 'new order' parameter can emerge (p. 2983), and they stress that 'the system stabilizes the new order via feedback to individual actors' (Meynhardt et al., 2016). They further suggested research on social embeddedness, which is one of the starting points of this study.

The current ecosystem discussion emphasizes the role of orchestration in ensuring the functionality of innovation ecosystems (Autio, 2022; Ritala 2009). Companies are challenged by the need to deal with increased dynamism and achieve proficiency in orchestrating ecosystems, which has been suggested as a solution for ecosystem leaders (Linde et al., 2021). Although previous studies have characterized orchestration as a process of multiple actors, the responsibility is often set to a lead firm or role that requires the acceptance of other members (Dessaigne & Pardo, 2020; Perks, Kowalkowski, Witell, & Gustafsson, 2017). There is evidence that orchestration in open and closed systems differs and that open-system orchestration resembles the construction of loosely connected communities of actors (Giudici, Reinmoeller, & Ravasi, 2017).

Innovation and business ecosystems often appear disconnected in research and practice, and companies move between collaboration activities according to their current interests (Nuutinen et al., 2024; Valkokari, 2015). This further challenges the organization of collaborative innovation for sustainability solutions within evolving ecosystems, where self-organizing might be the key characteristic enabling progress in addressing complex challenges. It remains unclear how ecosystem actors ensure progressive knowledge creation and its successful application in business for amplified sustainability impacts. In our view, this corresponds to the central idea of continuous innovation studies.

2.2 | Collaborative continuous innovation

The power of collaboration has long been acknowledged in innovation research and is widely promoted by open innovation theory development (Bogers et al., 2017; Chesbrough, 2003, 2017; Chesbrough et al., 2014). Sustainability targets can be successfully reached by applying an open innovation approach, and it can foster meaningful collaboration with complementary partners and create a deep sense of purpose (Bogers et al., 2020). This case study of the food and beverage industry highlights leveraging open innovation for sustainability, going beyond a solid business case, navigating opportunities and challenges with new business models, and achieving early wins for societal impact and long-term vision (Bogers et al., 2020) but it still relies on the central role of a leading firm.

Continuous innovation research has created a strong understanding of how a company can maintain its competitiveness and be capable of renewal, which requires continuity, established processes and 'a learning culture' (Boer & Gertsen, 2003; Lianto et al., 2018; Martini

et al., 2013). The core of continuous innovation is a synergistic combination of exploratory and exploitative activities whose role in companies' success has long been acknowledged (Boer & Gertsen, 2003; Lianto et al., 2018; Martini et al., 2013), but it is unclear how this can be achieved in the ecosystem context.

The majority of the literature is from a single-firm perspective, although ideas from open innovation have long been applied (Chesbrough, 2003, 2017), for example, crowdsourcing ideas from large user communities and collaborating with grassroots-driven open communities (Wolf & Bernhart, 2022). However, wicked problems necessitate ongoing and deeper collaboration (Dahlander et al., 2021). Collaborative and connectivity-based continuous innovation strategies seem to be rare, and development strategies often tend to focus on the internal resources of the company with a 'do-it-yourself' mentality (Lianto et al., 2018). Significant sustainability progress in an industry requires contributions from many different actors, and collaboration in evolving innovation and business ecosystems provides a natural place for this.

One of the rare empirical studies bringing continuous innovation into the ecosystem discussion highlighted managers' recognition of the importance of external parties in innovation processes and the need for alignment and strategic positioning (Visscher et al., 2021). However, not all businesses are actively involved in such ecosystems. The study identified two layers within innovating ecosystems: an open explorative layer for identifying innovation opportunities and a semi-closed exploitative layer for delivering value to customers (Visscher et al., 2021). It also acknowledged challenges that can lead to frustration and even withdrawal from the explorative layer (*ibid.*), including linking activities and tensions between these layers. Creating a unified innovation process in a networked setting without a central decision-maker and varying industry commitment can be daunting and lengthy and may even be infeasible. However, business ecosystems have demonstrated how these systems can evolve and self-organize according to benefits for the end customer (Meynhardt et al., 2016; Moore, 2006).

How can this power of self-organizing be exploited for sustainability in the context where the needed and possible improvements might be scattered in the value network and only very gradually create something that provides a clear benefit for the end customer – and all of us (an industry that is better balanced with the planet)? Can the glue that connects different parties be found in this very concern that many of us share (as indicated by Bogers et al., 2020) in people who participate in collaboration? How can they cope with the shorter-term targets of their own organization and the potential longer-term sustainability impact of collaboration? The importance of people's perspectives and social networks for innovation, both intra- and inter-organizations, is acknowledged but still underutilized (Di Vincenzo & Iacopino, 2022; Hemphälä & Magnusson, 2012; Lianto et al., 2018; Ritala et al., 2022). This provides a further interesting starting point for our study: to dig deeper into the social construction of collaboration with a practice perspective in the context of networked innovating.

2.3 | Innovating practice and collective learning

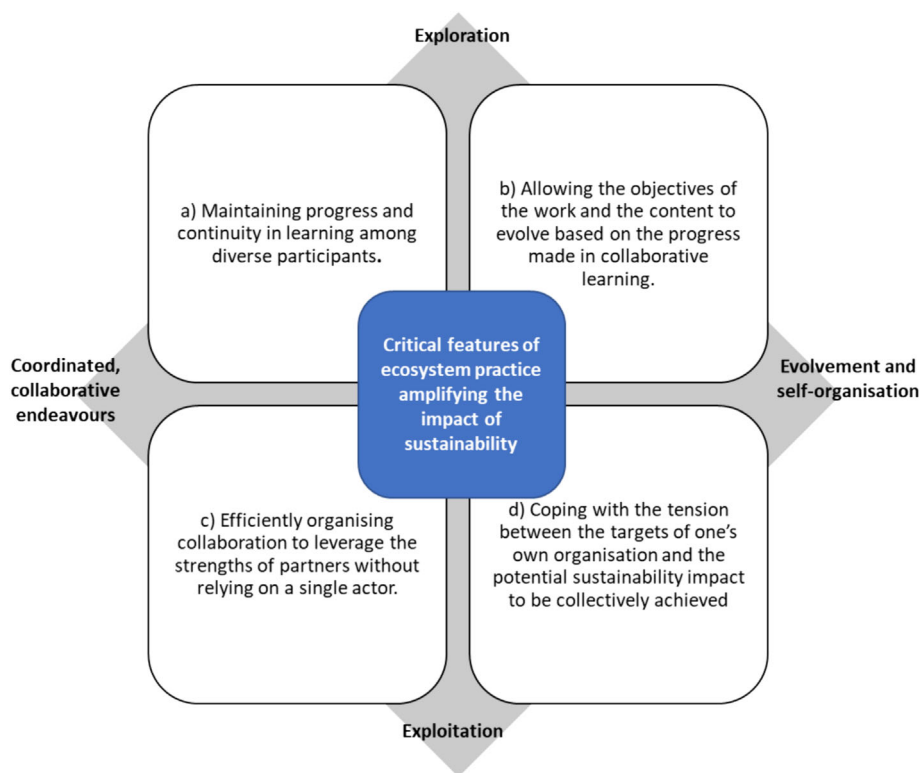
The practice-based approach is widely used to explain not only people's actions but also the meaning behind those actions and how practices form and constitute the collaboration; thus, it has clear relevance for explaining the internal dynamics of collaborative innovation (Cirella & Murphy, 2022; Russo-Spena et al., 2017; Yström & Agogué, 2020). The logic of the practice is seen as necessary for creating order and continuity in an organization, with the activities themselves generating a community and knowledge an activity (a knowing) (Corradi et al., 2010; S. Gherardi, 2009). The 'continuous struggle to meet identified demands and embrace possibilities to create something new and better' (Mele et al., 2017, p. 3) drives actors to participate in innovation. Ambiguity and opportunism, driven by self-interested motives, have been recognized as 'the dark side of agency' (Mele et al., 2018). However, the interests of the organization in which an individual works and the alignment of these interests with the ecosystem objectives can enable sustainability progress through real exploitation in business.

The practice perspective provides a tool for unravelling co-innovation in ecosystem collaboration, allowing us to adopt a perspective that is not limited to an individual or company but to a community in the intersection between different organizations held together by practice. This approach provides a vernacular for innovation that focuses on 'innovating as an ongoing and dynamic process ... and regards practices as natural logi of novelty' (Russo-Spena et al., 2017, p. 3) instead of something that maintains established routines. This dynamic processual view resonates well with the continuous co-innovation definition and the evolving nature of ecosystems. Models and concepts are used to analyse and support the understanding of phenomena in a particular context and to produce new concepts that help different actors 'grasp social reality' (Mele et al., 2017, p. 30).

2.4 | Tentative conceptual framework

Figure 1 summarizes the tentative theoretical framework of the critical features of an ecosystem practice empowering industrial sustainability transformation through continuous innovation. Collective learning processes pursuing something better and benefiting ecosystem participants' perspectives and competences require that the content in which they work changes according to their progress in learning about how to tackle the wicked problem of sustainability. The framework represents two tensions to be balanced in collaborative innovation, enabling transformation and following four requirements for ecosystem practice that dynamically adjust according to the understanding of the wicked problem. The first well-known tension is between exploration and exploitation, and the second is between coordination and self-organizing activities, which together provide four requirements to be used in case analysis.

FIGURE 1 The tentative theoretical framework of an ecosystem practice. Grey arrows represent two tensions to be balanced and boxes four requirements for the practice. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/leam.12630)]



3 | RESEARCH DESIGN

3.1 | Research strategy

This study focused on complex social issues to explain the internal dynamics of collaboration within ecosystems. An exploratory study employing an abductive approach to examine this phenomenon 'in a new light' (Robson, 2002, p. 59) aligned well with our objectives. The research methodological approach to the cases is based on a qualitative case study research strategy (Yin, 2014). To provide information about critical features (considering cross-industry collaboration in sustainability transformation), we intentionally selected ecosystem cases representing industries that have high sustainability relevance and an important role in the Finnish economy. Furthermore, in each case, there were cross-sectoral characteristics since information technology (IT) sector involvement was selected and all cases had at least one actor in that sector. An additional criterion was their availability to the researchers (access for collaboration). They were similar enough to provide comparability, but their inherent differences reflected the diverse realities within ecosystems and were anticipated to generate variations in internal dynamics. Thus, choosing these three cases (see next chapter) provided a meaningful and manageable setting for our study. The researchers were not involved in every activity of the studied ecosystems and thus reading practices both 'from inside' and 'from outside' were applied (S. Gherardi, 2009).

3.2 | Empirical cases

Table 1 introduces the selected cases. The first ecosystem case, 'Case A' links Finnish forest industry challenges with ICT innovation in an open marketplace. Case B builds a business ecosystem and experimentation digital platform to foster intelligent data-based services for smart buildings. Case C connects Finnish manufacturing entities and small and medium-sized enterprises (SMEs) for agile co-creation in real-world production environments.

The overall target of the case ecosystems was to enable multi-actor research, development and innovation activities towards sustainability. They all utilized proof-of-concept (PoC) tracks that form the core of joint activities. PoCs are based on business needs, voiced by companies and tackled by on-demand combinations of research and SME services. PoC results represent new technological knowledge and form the basis for later business impact analyses. All cases targeted the involvement of innovative solution provider companies (typically start-ups or SMEs) in the work of the innovation ecosystem to solve the use cases set by industrial partners.

3.3 | Data collection and analysis

The empirical research was conducted by a multidisciplinary research team, including behavioural science, ICT, innovation and ecosystem researchers. In these cases, the researchers had access to the

TABLE 1 Case descriptions.

Characteristics	Case A	Case B	Case C
<i>Domain</i>	Forest industry	Smart buildings	Manufacturing industry
<i>Sustainability perspective</i>	Willingness to reinvent industry as a sustainable solution with renewable materials.	The built environment as one of the biggest sources of CO ₂ and where climate change will severely hit.	Potential related to zero waste and energy-optimized manufacturing processes and product life cycle.
<i>Purpose</i>	A collaborative innovation platform connecting the forest industry, Finnish vendors, and the digital sector to lead globally through learning and innovation.	An innovation initiative shaping a dynamic ecosystem to redefine the future of construction.	A production-focused innovation ecosystem with technology proofs-of-concept and an extensive experience-sharing program. Phase 2 project.
<i>Implementation focus</i>	Innovative digital solution proofs-of-concept for the forest industry.	Intelligent service proofs-of-concept for smart buildings.	Digital solution proofs-of-concept for more efficient production.
<i>Ecosystem type</i>	Innovation ecosystem	Digital platform-based innovation ecosystem	Innovation ecosystem
<i># partners</i>	22 companies + 3 research organizations	6 companies + 1 research organization	8 companies + 4 research organizations
<i># participating companies</i>	12 large companies, 9 SMEs*	8 SMEs	49 SMEs
<i>Partner types</i>	Case owner companies, solvers, 'catalytic actors', research, funding	Core partners, developers, research, funding	Case owner companies, solvers, research, funding

Abbreviation: SMEs, small and medium-sized enterprises.

TABLE 2 Collected case material.

Data	Case A	Case B	Case C
<i>Background material</i>	Project plan	Project plan	Project plan
<i>Interviews</i>	Initial interviews: 22 (all company partners) Use case-specific interviews: 50	Initial interviews: 7 (all partners) Stakeholder interviews: 25	Initial interviews: 5 companies + 3 research organizations (Phase 1); 8 companies + 4 research organizations (Phase 2)
<i>Workshops</i>		7 (2 with only the partners, 4 with stakeholders, 1 with SMEs)	
<i>Seminars and other events</i>	Kick-off and final seminar	Kick-off and final seminar, two public events	Kick-off and final seminar Sprint review seminars every 2–3 months to review the overall status and plan continuation, combined with SME bazaars to showcase commercial offerings
<i>Meetings</i>	Steering group meetings: 10 Monthly meetings	Steering group meetings: 19 Weekly meetings of the whole consortium	Steering group meetings: bi-weekly management meeting with all partners for operative decision-making Weekly core group meetings between research organization representatives
<i>Documentation in digital collaboration tools</i>	Progress reports, chat discussions, presentations, etc.	Progress reports, chat discussions, presentations, etc.	Progress reports, chat discussions, presentations, etc.

Abbreviation: SMEs, small and medium-sized enterprises.

co-creation processes in three emerging ecosystems, and the selected cases were comparable and complementary. The unit of analysis was an ecosystem (instead of individual firms). Ecosystem membership defined the companies in which we were interested based solely on their roles within that ecosystem.

Following the basic components (p. 11–12) of qualitative research (Strauss & Corbin, 1998), we collected rich data (Table 2) contributing to construct validity (Yin, 2014, p. 45), utilized procedures such as coding (Table 3), wrote memos, drew diagrams, and gave written and verbal reports. The research writing of memos was not undertaken

TABLE 3 Demonstration of early phase coding the research material.

Source material	Examples of coding
Meeting	<i>(a partner asks) [communication] how can we build [collective action] an ecosystem [identity] that is open [openness]? It's a tricky question [difficulties].</i>
The situation described in an observation memo	<i>One participant presented a template [common tools] for a start-up event [activity] describing topics [object of work] that would be interesting to get [planning, progress]. This was criticized [difficulties] that there is no ownership [ownership, roles] (of the template inside the ecosystem) that takes care that the information is filled in [activities, efficiency of collaboration] and it does not take into account [difficulties] that start-ups are only focusing on getting their things done [roles, objectives, differences, resources].</i>
Meeting	<i>(a partner asks) [communication] how can we go to the next projects [continuity of collaboration and learning] if you can't find [tensions] your own angle [roles] to this one [identity]?</i>

according to a predetermined schedule or system of task allocation' (Birks et al., 2008, p. 69), and the memos and diagrams varied in their style, length and content but served to reach analytical distance from the data and progress conceptualization (Strauss & Corbin, 1998, pp. 218–220).

The researchers participated in workshops in a dual role: as facilitators and contributors. Data collection was framed by the overall purpose and plan for each collaboration, resulting in a natural difference in the quality and amount of data. The themes of the initial interviews included the objectives and motivation to collaborate, expectations related to the method of collaboration and organization, and business opportunities. The material started with collaboration project initiation and ended 2 and a half years later for Case A, 2 years later for Case B, and 3 years later for Case C.

As is typical of the abductive process, the theoretical and empirical fieldwork and case analysis evolved simultaneously (Dubois & Gadde, 2002). The literature generating the tentative framework was searched according to the questions raised from empirical data — and vice versa. The main motive of the literature analysis was to develop a framework (as a cornerstone of matching) and define (redefine) the focus of the study (through continuous evaluation of the framework, data sources and analysis).

We employed both within-case analyses, offering narrative descriptions of each case, and cross-case analyses, comparing various categories representing diverse theoretical and data-driven constructs (Eisenhardt, 1989). This approach ensures favourable conditions for both internal and external validity, as well as reliability, and is further reinforced by the incorporation of theoretical frameworks, as emphasized by Yin (2014, p. 45), for testing research design quality. Several

rounds of analysis were conducted on the available material, asking questions (Strauss & Corbin, 1998, pp. 73–78) (e.g. what does this say about collaboration, and why does it seem to be important?) and making theoretical comparisons (Strauss & Corbin, 1998, pp 78–82) based on early phase inductive conceptualizations pursuing towards qualitative rigor (Gioia et al., 2012). Table 3 demonstrates the preliminary coding in a within-case analysis. Not all material was analysed to this level of detail, but we moved to different categories (early components of the framework, Figure 2). Other features were also recognized, but those evident in each of the cases and matched with the requirements recognized in the tentative framework in Figure 1 (emerged in the earlier phase of the analysis) were included in the revised conceptual model (see Conclusions section). These two frameworks are used in the “Results” section to provide transparency to the process.

4 | RESULTS

4.1 | Critical features of ecosystem practice

The empirical research created an understanding of the critical features of ecosystem practice, which we present with the help of the identified requirements (a–d in Figure 1) and the building basis for the revised framework items (1–4 in Figure 3).

The fundamental requirement for an ecosystem practice was the necessity of maintaining progress and continuity in learning among diverse participants [a]. In Cases B and C, there was a small core group [c, 3] that enabled smooth organization [c] and adjustment of plans and collaboration activities [2], as well as interaction with a broader group of participants [3]. In Case A, there was one large active group [1]. Consequently, forming actual working groups to realize the set vision was time-consuming [c, 3] within a broad group of participants with different views and interests about collaboration [c, d, 4]. In Case B, the intensity and trust among the core group [3 close] were developed through a systematic process [2], where challenges to solve were defined together [b, 2] and companies with ‘missing parts’ were sought [b, 1]. However, in Case A, trust among participants was built during joint activities [a, 1 open]. Their activities were organized in use case groups [b, c]; that is, not all ecosystem members were involved in all activities [b, 2], and therefore, ecosystem-level communication was critical to sharing a vision and strengthening the trust between all actors involved [1]. Creating trust among the identified participants seemed easier than engaging in new expertise [1]. Trust was more easily built within smaller groups in our cases [1], but the clarity of the vision also played a significant role. When the core group [c, 3] managed to organize participation (also outside the core group) [1] so that the progress [a, 1], according to the vision, was evident [2], broader trust in the ecosystem strengthened. It also made the vision more alive [a, 1]. This enabled participation with varying intensity, thus making it possible to adjust how closed or open different activities were according to the present understanding of what was needed for progress. Balancing open and closed collaboration emerged as the

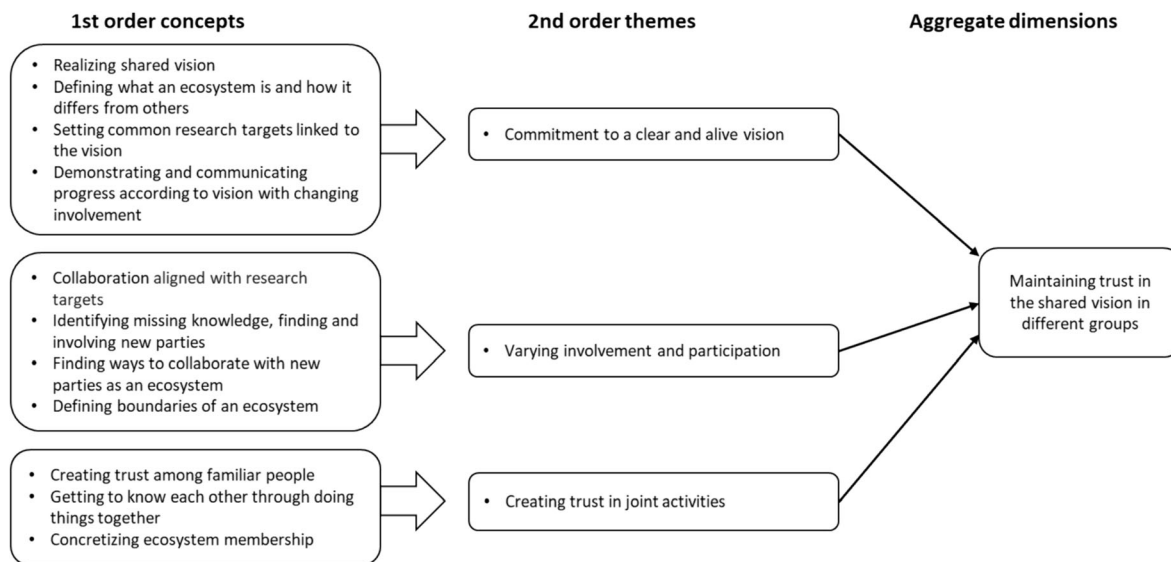


FIGURE 2 Example of inductive reasoning guided by Gioia et al. (2012).

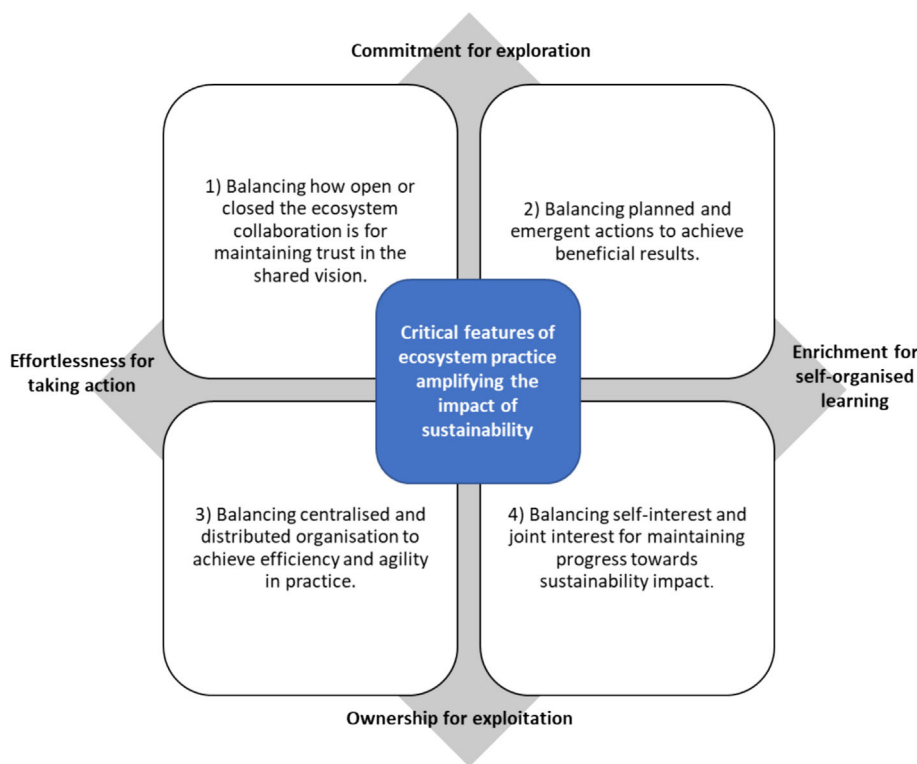


FIGURE 3 Revised conceptual framework on critical features of ecosystem practice empowering sustainability transformation. The four characteristics of an empowering ecosystem practice (at the end of the arrows) are based on the successful balancing of the four critical features (white boxes) identified in continuous innovating. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/etm.12630)]

first critical feature of a practice to maintain trust in a shared vision when addressing wicked problems in ecosystems [1].

The second requirement involved allowing the objectives of the work and the content to evolve in accordance with the progress made in collaborative learning [b]. The core group in Case C deliberately created practices that broke the existing method of working; the identified problem [2] to be solved was thoroughly examined by researchers [c, b] before deciding who should start working on it [3,2]. This led to more comprehensive ideas [a] that required multiple actors

to participate in the development [1,2] of the solutions [b]. Core companies were typically flexible [c] in how straightforward they were in proceeding and how much they counted on common plans or self-organization [b, 2]. In Case B, the commonly created understanding of the meaning of the vision enabled new participants to be sought through challenge competition [c, 3], with more focused calls leading to a new mix of participants [c], experiments and PoCs [b, 2]. The results achieved together with the winners again fed the next competition call [b, 2] and generated more interest (both inside and outside

of the present collaboration parties [1]). Case A demonstrated how planned actions at the ecosystem level and emerging activities within use case teams [c, 2] were balanced by practices supporting feedback loops within the ecosystem. The belief in the ecosystem's capability to achieve beneficial results was crucial for the participants' interest and efforts to explore, and maintaining this by balancing planned and emergent actions was the second identified critical feature of the practice.

The third recognized requirement was organizing efficient collaboration that benefited from the participants' strengths without dependency on a single actor [c]. The trade-off of fast progress based on existing solutions or bilateral deals in exchange for a more thorough understanding of the possibly broader sustainability impacts [d] was visible in the cases [c, 3]. In Cases A and B, there was a common aim to work in a very agile way [c, 3], but this meant different things to the participants, which was confusing. Both cases struggled with connecting different activities [a, b, c, 1, 2, 3]. In Case A, agility [c] was understood differently among the industrial sectors; IT suppliers were used to performing development work in customer projects, whereas user case companies expected suppliers [d, 4] to participate in solution development [3]. In Case B, the key person in the company with a central role [c] changed mid-project, disrupting plans and resource allocation [3], which hindered learning. When the big picture became blurred [a], joint planning was intended [c, 3], but when planning took (too much) time from the more focused work, where participants saw the possibility of reaching real results [b, 2], the interest in participating was rather low, unintentionally decreasing the sense of unity and togetherness. In Case C, the developed model for organizing the work [c, 3], according to thoroughly examined problems [b, 2], was strong enough for a new participant to understand it and join the collaboration without difficulty [a, 1, c, 3]. It was also supported by, for example, researchers' knowledge [c, 3]. In this case, the participants' clear roles in the problem definition ensured that existing knowledge was utilized instead of starting from scratch. However, if the participants felt that their time and effort were wasted [c, 3], their motivation to contribute lessened. The third critical feature was closely related to the previous one: how centralized versus distributed organizations were suitable for the situation and the parties currently involved. Maintaining efficiency and agility that benefits from the parties' strengths required balancing centralized and distributed organizations, without dependency on a single actor's interest was the third critical feature [3].

The fourth requirement was coping with the tension between the (shorter-term) targets of one's own organization and the potential sustainability impact to be collectively achieved in the long term [d]. In all cases, the participants formulated integrated or linked solution concepts (PoCs) [2] and tested them to evaluate whether there was potential for business that matched their business strategies [d, 4]. For example, in Case B, the PoC related to a real construction site [b] helped to create a common understanding of how expertise and business could be linked [c, d, 4] to support the efficiency of work and save resources at the construction site, thus contributing to the sustainability target [4]. In Case A, there were clearly stated roles for

ecosystem actors (use case owners, solution [technology or service] providers and researchers) that supported the visibility of the interests of different ecosystem actors [d, 4]. The continuously developing understanding of the nature of the problem [a, b] and how the solutions [b] could be integrated for broader impact seemed to enhance the clarity of the roles and business prospects [d, 4]. Coping with the short-term goals of one's organization with the potential long-term sustainability impact created collectively in the future necessitates that cooperation is attractive in terms of sustainability effectiveness and that roles are clearly defined. The potential sustainability impact serves as a criterion against which an individual can determine and justify their role, both within their own organization and within the broader ecosystem and among stakeholders. In conclusion, balancing self- and joint-interest to maintain progress towards sustainability that serves attractiveness and supports clear roles emerged as the fourth critical feature of practice that could support transformation [4].

4.2 | Transformation with ecosystem practice that adapts according to learning

While tangible progress in industrial sustainability was not always evident in our cases, it did not imply a lack of commitment. The discontinuity and confusion in collaborative work organizations affected internal collaboration dynamics, necessitating the adoption of adaptable practices (change balance in dimensions through reorganizing collaboration) to pursue sustainability goals. Challenges arose in effectively coordinating cooperation towards sustainability objectives, with promising initiatives sometimes stalling and development paths being halted due to misalignment with key players' interests. The introduction of new actors, such as startups and SMEs, lacked influence over topic selection or community membership. Personnel changes further impacted community dynamics, underlining the need for innovation practices to balance continuity with openness to new preferences and methods to strengthen collaboration. The transition from planning to implementation often faltered due to personnel changes, resulting in scattered lessons and limited progress on challenging issues. These challenges underscore the dynamic nature of collaboration in ecosystems. To sustain progress, participants must adapt their methods of innovation based on learning related to the wicked problem of sustainability and how collaboration dynamics evolve.

5 | DISCUSSION

Following the set core research question on the critical features of an ecosystem practice empowering industrial sustainability transformation through continuous innovating, we conducted an abductive study. Based on the comparison between the three ecosystem cases and reflecting on the tentative framework, we identified four dimensions of ecosystem practice in multi-actor collaboration that impact internal dynamics and ecosystem progression in addressing the

wicked problem of sustainability: (1) openness – closedness of collaboration, (2) planned – emergent, (3) centralized – distributed and (4) self-interest – joint interest. The status of the four identified dimensions are the main features of a situationally adaptive ecosystem practice that was interpreted to feed continuity in common learning with trust and a clear vision, beneficial results, agile and efficient organization, and attractive and clear roles, thus supporting transformation. Our empirical results demonstrated that plan changes, organization methods, people and roles seemed to be natural in the innovation activity of evolving ecosystems, causing the need to maintain situationally adaptive practice. There may be other critical features, but these emerged from the studied cases as being critical based on the recognized requirements. As noted previously, the nature of sustainability challenges differs among industries (which were represented by the cases), but these features related to collaborative learning were recognized in them all.

The dimensions need to be balanced situationally to achieve the targeted (amplifying) sustainability impact. As is typical of wicked problems, the problem itself is complex and multifaceted, and our cases showed how understanding increased gradually along with exploring the phenomenon, developing and testing solutions and learning about their impacts on sustainability. The ecosystem partners gradually learned more about the nature of the problem, how it could be approached, what type of competence was needed to solve new emerging problems, how the developed solutions worked and how the ecosystem practice could enable continuous progress. The critical features highlight aspects that are at least relevant to being situationally and contextually balanced in an ecosystem practice. Thus, the practice should be dynamic and ‘pulse’ with an accumulated understanding of what works and what is *not yet known*, in addition to organizational cohesion maintaining the continuation of ‘innovation’.

Next, we discuss the findings by interconnecting the two main tensions between exploration and exploitation and between coordination and self-organizing activities (see Figure 1) with the aim of progressing with the theoretical framework.

5.1 | Sustainability feeds continuity in exploration and exploitation in ecosystem practice

A clear and purposeful vision, when shared with partners, fosters collaboration and motivation. This vision should remain flexible and adapt to progress. Collective learning and practice, as seen in prior research (Gherardi, 2009; Kallio et al., 2017; Russo-Spena et al., 2017) can sustain continuity independently of individual participants, organizational boundaries and hierarchical structures. We argue that, as an integrated part of the vision, sustainability can serve as a unifying concern, driving collaboration through shared motivation and learning culture and maintaining continuity and energy for innovation and openness to share insights and engage new expertise as needed. Each step taken towards sustainability in products, services or processes within the industry can contribute to ecosystem collaboration when shared openly. It is not necessary for all business endeavours to

depend directly on multiple ecosystem partners' offerings, but they should align with the broader sustainability mission, reinforcing the belief in its feasibility (cf. (Bogers et al., 2020). This can help manage the tension between an organization's interests and ecosystem collaboration (cf. (Visscher et al., 2021).

5.2 | Learning to take care of orchestration in ecosystem practice

In our cases, a shared vision and a drive to achieve beneficial results spurred a search for new participants. This motivation, coupled with the dynamic self-organization within the ecosystem, allowed for the integration of fresh expertise and boosted collaborative learning. The effectiveness of this collaboration in challenging existing norms and driving transformative change hinges on the strength of the new practice. Specifically, it depends on how these practices connect individual actors to the larger unit, demonstrating potential sustainability impacts at both the ecosystem and individual participant levels. This perspective adds nuance to Meynhardt et al.'s (2016) emphasis on individual actors' roles and value evaluation in shaping new logic. It aligns with Moore's (2006) framework of ecosystem coevolution, highlighting the emergence of co-evolution from actor-to-actor interactions at the micro-level. Our cases underscore the need to balance planned and emergent actions based on joint learning and the outcomes achieved, reflecting the intertwined nature of self-organization and maintaining continuity in collaborative open innovation processes.

Our results also indicate that it is difficult to establish a common and continuous innovation process (Boer & Gertsen, 2003; Lianto et al., 2018; Martini et al., 2013) in a changing network setting in which no one has a legitimate position for control (although this might be expected by other actors), the focus and actors of the activity are occasionally unclear, the nature of the solutions or expertise needed (also outside the industry sector) are not initially known and each actor has innovation processes and practices. As noted in the introduction, the current ecosystem discussion emphasizes the role of orchestration in ensuring the functionality of an innovation ecosystem (Autio, 2022; Ritala et al., 2009). Thus, empirical studies have rarely tracked interdependencies across actors and their activities over time (Phillips & Ritala, 2019). This study indicates that the needed coordination or orchestration can be conducted as a shared effort (Dessaigne & Pardo, 2020; Perks et al., 2017) motivated by maintaining joint learning. This becomes more challenging when the views differ (e.g. on agility). This is expected to be even more challenging when progress in learning necessitates new parties across industries that can increase the transformation potential but challenges in organizing as well. Specific activities that support joint reflection on the critical features of a practice by ecosystem actors can promote feelings of capability and enable them to contribute effectively to joint progress in tackling wicked problems. Thus, industry players must be empowered together to maintain continuous innovation in an ecosystem.

6 | CONCLUSION

6.1 | Theoretical implications

The overall motive behind this study was to understand how sustainability transformation (Tonelli et al., 2013) can be accelerated by empowering industrial players. We focused on how actors within an ecosystem cultivate the dynamic adaptation of ecosystem practice to tackle sustainability challenges by defining the critical features of an ecosystem practice that empowers industrial sustainability transformation through continuous innovating.

Figure 3 summarizes the revised conceptual framework on critical features of ecosystem practice, highlighting the four characteristics of an empowering ecosystem practice that are based on the successful balancing of the four critical features identified in continuous innovating. Commitment to exploration refers to a strong dedication to the collaborative goals and the shared vision of the ecosystem and is based on a successful balance between critical features 1 and 2. Empowerment is facilitated through ownership, that is, taking pride in one's role and contributing to the efficient collaborative effort to progress toward sustainability within both the ecosystem and one's own organization. Feeling a sense of ownership implies a personal investment, commitment and accountability for the outcomes that are critical for achieving business based on ecosystem collaboration. Effortlessness refers to the ease with which tasks are accomplished through the seamless collaboration needed to take action. It relies on trust in the shared vision and the efficiency and agility of the practices reached through balancing critical features 1 and 3. Enrichment implies a positive advancement or improvement associated with gaining new insights and knowledge through ecosystem collaboration. The journey is ongoing and continues to present new learning opportunities, benefiting from the evolving nature of ecosystem collaboration according to the achieved results and potential sustainability impacts.

According to the framework, through the four critical features, an ecosystem practice emerges that empowers industrial players in sustainability transformation. It is characterized by the commitment and ownership needed for a synergistic combination of exploration and exploitation in ecosystems, thus feeding the continuity of collaborative innovating. Furthermore, it is characterized by effortlessness and enrichment of its participants' knowledge in collective actions, fostering progress in addressing the wicked problem and renewal of industry.

As such, the issues (such as vision, trust, and openness) included in the critical features are not novel, which is natural since they were developed using an abductive process related to the existing literature (see, e.g., (Boer & Gertsen, 2003; Bogers, 2011; Bogers et al., 2020; Chesbrough, 2017; Lianto et al., 2018; Martini et al., 2013; Shipilov & Gawer, 2020). These features emerged as relevant in our research, but others are likely to be found. The novelty of the results of our research lies in the dynamic construction of ecosystem practice in the context of innovation as a potential approach for accelerating industrial sustainability transformation. However, since these seemed to be relevant in all studied ecosystems, they could also offer something for

wider cross-industry cooperation, thereby speeding up the sustainability transformation. ICT sector involvement in each of the cases revealed some cross-industry tensions in the ecosystems that might not be similar in other types of cross-industry innovation. This study provides an interesting starting point for studies on cross-industry settings.

As a main theoretical contribution to the contemporary discourse (Bogers et al., 2020; Dahlander et al., 2021; Lianto et al., 2018; Nuutinen et al., 2024; Tonelli et al., 2013), we argue that ecosystem practice can serve as catalysts for continuous cross-industry innovation by connecting actors with varying degrees of intensity, driven by their concern for addressing wicked problems and guided by the imperative to meet their organization's targets, to jointly learn how to address such challenges, thereby accelerating change. The essence of industrial transformation lies in the emergence of ecosystem practices characterized by commitment, ownership, effortlessness and enrichment.

From a future research perspective, this creates a seed for understanding the adaptive self-organization of the ecosystem required for continuity in learning in a changing multi-actor setting (cf. (Hou & Shi, 2021) and advances innovation theory in how wicked problems can be addressed together as a continuous exploration and exploitation process of the ecosystem (cf. (Bogers et al., 2020; Visscher et al., 2021). We propose future studies focusing on these processes or developing practical tools based on the framework to help ecosystem actors maintain an ecosystem practice that enables continuous open innovation and supports 'a learning culture ... to continuously improve and self-renew to adapt to' (Lianto et al., 2018) sustainability targets.

In summary, conceptualizing the ecosystem as a practice makes it possible to detach from the perspective of individual companies (Adner, 2017; Lianto et al., 2018) and to examine the dynamics of networked innovation power (understood as innovating; (Mele et al., 2017)) across several borders. It brings together an open and a closed ecosystem (cf. (Giudici et al., 2017), although innovation and business ecosystems may have different boundaries. Furthermore, the co-evolving nature of ecosystem practice makes it possible to link exploration and exploitation activities more closely in a network setting (cf. (Autio, 2022; Visscher et al., 2021). It also offers an interesting opportunity for the self-organization and evolution of ecosystems without expecting a permanent leader or orchestrating partner (Linde et al., 2021). The study also supports the notion of collaborative or distributed innovation in solving the industrial sustainability challenge (Bogers et al., 2020; Tonelli et al., 2013).

Considering this research, it is particularly important to understand the social construction of ecosystem practice among changing actors and how shared concern and progress in collaborative learning connect exploration and exploitation activities in an ecosystem, creating continuity and novelty and thus enabling the ecosystems' growing impact on sustainability transformation. We encourage future research and development on the critical features and characteristics of an empowering ecosystem, particularly on what they can offer to support cross-industry collaboration in ecosystems aiming to tackle sustainability-related challenges.

6.2 | Managerial implications

Industrial ecosystems (construction, manufacturing and forest industries) face substantial pressure for sustainable development. Sustainability is often regarded as a requirement to meet future regulations and change customer behaviour. However, addressing sustainability impacts goes beyond individual companies; the entire business environment must be considered. Urgent climate challenges offer both business opportunities and shared motivation for better solutions, altering the business landscape and creating new risks for passive actors.

Solving systemic challenges necessitates collaboration among various actors, and the expertise needed is not always found among current partners or even inside one's own industry sector. This challenges traditional approaches to collaboration, innovation and business. Active participation in ecosystem-level innovation and dynamic shared practices that facilitate continuous learning are essential. In the multi-actor setting, diverse perspectives exist on relevance and collaboration methods. Instead of seeking a single optimal approach to organization and cooperation, we emphasize the emergent nature of practice, enabling self-organization and harnessing the innovation potential of multiple players.

6.3 | Limitations

This study was qualitative in nature; thus, it is not free from subjective influences (Birks et al., 2008). However, following the guidance of qualitative research helped maintain quality in the research process. Although this study utilized four tests to maintain the rigour of social research, it remained susceptible to the inherent constraints characteristic of case studies. Three cases provided only a starting point for exploring features of ecosystem practices that may help in cross-industry learning to expedite transformation. Nevertheless, the application of these tests demonstrates that at least one recommended approach was employed in each aspect, as outlined by Yin (2014, pp. 45–49). Our study employed three cases to prevent excessive focus on a specific industry. However, this approach inadvertently limited our ability to delve as deeply into the social construction within each individual case as is typical in practice-based studies (Mele et al., 2017; Yström & Agogué, 2020). In conclusion, while reporting an abductive study poses challenges (Dubois & Gadde, 2002; Mele et al., 2018), we have strived to address them. Our study provides valuable insights, paving the way for future research.

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DATA AVAILABILITY STATEMENT

Author elects to not share data.

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