4. Sustainability transitions by ecosystem innovation

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INTRODUCTION

Environmental degradation and social injustice pose increasingly urgent challenges for the contemporary global society, such as those targeted by the United Nations' Sustainable Development Goals (SDGs). By nature, issues such as biodiversity loss, global warming, and resource depletion are all *wicked problems* that call for understanding of the complex interdependencies between processes at multiple levels of inquiry (Craig, 2020). Such problems require system-level solutions that integrate technological, material, organisational, political, economic, and socio-cultural changes (e.g., Markard et al., 2012). Furthermore, these challenges often present a conflict between economic and social goals and require continuous discussion and work to be resolved (Leal Filho et al., 2010). In addition, solutions to such problems must be transdisciplinary since they transcend the boundaries of any individual discipline or level of inquiry (Wolff, 2022).

Solitary organisations working on incremental improvements of their existing technologies are unlikely to produce innovations resulting in socio-technical transitions (Adams et al., 2016). Instead, organisations interested in making system-wide changes to the socio-economic landscape must collaborate with numerous incumbent actors and stakeholders, including competing private organisations, passive users, and governments, which otherwise are likely to hinder major changes to their specific industry or milieu (Adner, 2006; Adner & Kapoor, 2016). Therefore, efforts to impact system-level changes towards sustainability create a need for new forms of governing collective actions (Gündoğdu & Aytekin, 2022; Kemp et al., 2005), as well as broad conceptions of corporate sustainability and corporate social responsibility (CSR) at the level of individual organisations (Aslaksen et al., 2021; Carroll, 2021). Transitions towards more sustainable production and consumption practices, often referred to as *sustainability transitions* or *transformation*, also require the proactive engagement of organisations across various sectors of society to address urgent environmental and social issues through collaborative innovation practices (e.g., Adams et al., 2016; Idowu et al., 2010; Louche et al., 2010). However, not all innovations aiming to support CSR will produce positive results for society (Louche et al., 2010).

In this chapter, we focus on the question of innovations that advance system-level sustainability transitions by drawing on the growing literature on *ecosystems*. The use of the ecosystem concept has become increasingly common in various literature streams, such as innovation policy (Järvi et al., 2018), entrepreneurship (Autio et al., 2018), strategic management (Jacobides et al., 2018), digital business (Cusumano & Gawer, 2002), human resources, careers and labour markets (Baruch, 2013; 2015; 2016), and education (Barnett, 2018; 2022). While the literature depicts ecosystems on various scales and with interest in

dissimilar defining features, they share an understanding that new knowledge creation and innovation increasingly depend on new collaborative arrangements. Synthesising previous literature, Thomas and Autio (2020, p. 16) define an *innovation ecosystem* as "a community of hierarchically independent, yet interdependent heterogeneous participants who collectively generate an ecosystem output". This definition highlights that ecosystems represent a distinct, non-hierarchical way of organising collaborative innovation activities around a system-level solution that differs from both market-based collaborations and collaborations in traditional business relationships or networks (Jacobides et al., 2018; Shipilov & Gawer, 2020).

The aim of this chapter is to explore the role of ecosystems in sustainability transitions. While the literature has recognised the potential of ecosystems in the creation of sustainability-improving solutions, for example in the context of the circular economy (Aarikka-Stenroos et al., 2021), this intersection remains largely unexplored as the literature on ecosystems has prioritised questions of economic value creation. Furthermore, system-level sustainability transitions call for new forms of collaboration to benefit from the potential in various industries and sectors in society. Therefore, exploring the ecosystem concept can enrich current understanding of the potential, and the challenges for sustainability-oriented, system-level innovation, and the implications of this view considering the broader notion of CSR. Besides offering new insights into organising collaboration for systemic sustainability transitions, we hypothesise that the ecosystems concept can enrich present views on CSR in terms of a more detailed discussion about governance. Similarly, the CSR discourse can be beneficial to the ecosystem discussions in management literature by directing attention to questions of how to ensure that ecosystems form around sustainability-improving objectives, instead of only forming around economic benefits.

In this chapter we ask the question: How do ecosystems facilitate innovation activities that enable sustainability transitions? First, we examine the connection between the concepts of sustainability governance and CSR. Next, we draw on the theories of socio-technical systems and transitions to propose that a third concept, innovation ecosystems, can be usefully employed to connect the first two when attempting to enable sustainability transitions in practice. Lastly, we discuss challenging implications and suggest directions for further research. However, we will begin by depicting a broader picture of the global challenges in a world of limited resources.

GLOBAL CHALLENGES AND THE ROLE OF BUSINESS

The planetary boundaries, which have received wide recognition in the last decade, indicate that climate change is only one in a line of global challenges to sustaining the current, although widely inequal, standards of living in the global society (Li et al., 2021; Rockström et al., 2009). According to the World Economic Forum's (WEF) latest reports (WEF, 2022a, 2022b), the top ten most severe risks over the next ten years are climate action failure, extreme weather, biodiversity loss, erosion of social cohesion, livelihood crises, infectious diseases, human environmental damage, natural resource crises, debt crises, and geo-economic confrontations.

Resource Deficiency and Wicked Problems

The global society depends on natural resources, which can yet only be secured from planet Earth. However, with the current production and consumption rates, these are being extracted at an alarming speed (International Resource Panel, 2019). While the global population is expected to keep increasing for decades to come, the redistribution of currently consumed resources for the growing middle class in the global south is predicted to generate a strong increase in global resource consumption – even at current population levels (Cavusgil et al., 2018; United Nations Department of Economic and Social Affairs, Population Division, 2022). The COVID-19 pandemic did momentarily halt an already slowing rate of economic growth (United Nations, 2022). However, hardly any evidence supports the assumption that this would produce a significant change in the long-term development predicted before the COVID-19 pandemic. Furthermore, the pandemic did not hit evenly, but made visible the deep social inequalities and the vulnerability of the economically disadvantaged (Patel et al., 2020).

When focusing on well-established societal challenges like climate change, the depletion of other social and material resources easily remains in the shadows. Yet this is a big issue for both companies and consumers, since mineral exhaustion can occur rapidly and it has an immense geopolitical and global economic influence (Crowther & Seifi, 2021; Seifi, 2021). If the course is not changed towards increased sustainability rapidly enough, the most dystopic scenes predict a final self-destruction of capitalism as well as democracy (Rundshagen, 2013). Under the influence of the neoliberal paradigm, steady growth has become a self-evident assumption in a world of finite resources (Crowther & Seifi, 2021). However, research has not yet been able to show that unlimited growth is possible on a limited planet, as this would require a full decoupling of economic growth from the use of planetary resources (Haberl et al., 2020). The consequences are immense and intricate, and unlikely to be resolved by currently imaginable actions alone. Therefore, the challenges posed by sustainability processes are regularly referred to as *wicked problems* (Rittel & Webber, 1973).

Wicked problems, as defined by Rittel and Webber (1973), are problems existing in constant flux. Lately, the concept has often been used to describe problems so complex that envisioning solutions requires a thorough systems analysis (Lönngren & van Poeck, 2021). The concept of wicked problems was originally applied to social planning, in which the effect of certain policies may cease once the next government implements new substructures. Craig (2020) argues that the same reasoning applies to planetary boundaries. Further, Craig criticises past attempts to simplify the sustainability challenge and argues that only systems analysis illuminating the constant changing environment and complex network of interrelationships can provide accurate actionable knowledge. Therefore, to remain in the safe operating space of the planetary boundaries, one must acknowledge the wicked nature of the interdependent challenges connected by such a network. Some authors even speak about *super wicked problems*, which according to Lazarus (2009), is done to emphasise the cost of time, i.e., the more time spent on solving the problems, the more costs the processes will amount to.

Societies are rapidly running out of time, while governments continuously fail to agree on measures which would meet the demands by climate scientists and satisfy environmental conservation groups (UN News, 2021). This is understandable, partly, because the systemic effects of decisive action are challenging to anticipate. According to Mancebo (2015), the solutions resulting from pressure from divergent political agendas are inefficient. Because of public opinion, they may even lead to mindless panic reactions, which mainly treat symptoms

and not diseases. One example of this is the trust in various environmental technologies and economic improvement as remedies, without considering that the solutions might create new problems. Simultaneously, radical political action may easily accelerate the ongoing polarisation in many parts of the world (Casal Bértoa & Rama, 2021). The reality of such developments became obvious in France, when raised fuel prices triggered a major protest movement opposed to unjust treatment of people in middle- and lower-income classes (Martin and Islar, 2021).

Quests for Change

Efforts to mitigate climate change, overconsumption, inequality, and other major global problems have produced a multitude of concepts to describe the challenges and how to overcome them. Such concepts include sustainability transformation, sustainability transition, sustainable transformation, sustainable transition, green transformation, green transition, and more.

Transformation and *transitions* are often used interchangeably to describe changes in the socio-technical systems or society at large. According to Hölscher et al. (2018), this overlap is caused by the terms being popularised in different discourses. They argue that while some seem to disagree on how these concepts differ in meaning, general use indicates a slight difference, since *transitions* is used to signify change in societal sub-subsystems, whereas *transformation* is used to signify wide-scale changes influencing the whole society (Hölscher et al., 2018, p. 2). In this chapter, we align with the general distinction of these authors. We define *sustainability transformation* as a turn towards conduct that is sustainable within a specific society for a significantly longer period than before. This is popularly expected to happen if enough attention is given to changes in technology and socio-economic behaviour. In this chapter, we focus on *sustainability transitions*, which we define as changes in various socio-technical systems, which collectively enable a wide-arching *sustainability transformation* through changes in socio-economic behaviour.

During the last few decades, many new actors have entered the sustainability policy scene, to participate in both the transition and the transformation towards sustainability. Beside states and international organisations, many local communities, companies, and non-governmental organisations are actively engaged in this assignment. Simultaneously, the complexity of ecological and social issues has become a challenge to the business world. Fast and unpredictable changes lead towards social transformation which, in turn, directs society towards a quasi-unlimited uncertainty (Rundshagen, 2013). The companies in the business arena of today must both sustain and grow in a demanding environment and in a risky time (Le, 2022). However, the current institutional framework for sustainability does not have the capacity to handle this challenge, since such a transition "demands serious changes in the way humans do business with each other and with the earth, in the face of a fractured, unequal world" (Mancebo, 2015, p. 2).

Turning the current trajectory to a significantly more sustainable future and remaining in the safe operating space of the planetary boundaries require enormous changes to technologies, cultures, and economies. Many of the carefully articulated sustainable development goals (SDGs) set by the UN demonstrate this view. Considering the current state of the economy, many of these goals may sound impossible to achieve. However, in the wake of the Agenda 2030, which introduced the SDGs, the notion of *decoupling* became popular. This idea builds on a wish to separate economic growth from its ecological impact (Fletcher & Rammelt,

2017). Supporters of this idea want to increase the value efficiency from natural resources and, thus, merge unlimited economic growth with environmental sustainability, but according to Fletcher and Rammelt, this is a poorly conceptualised fantasy. Furthermore, Haberl et al. (2020) argue that empirical research has been unable to challenge such criticism.

Nevertheless, various decoupling efforts have become mainstream. One popular umbrella concept incorporating these efforts is *green economy* (Loiseau et al., 2016; Perez, 2016). Among the related theories and concepts are the notions of environmental economics, ecological economics, cleaner production, waste hierarchy, bio-economy, industrial ecology, circular economy, nature-based solutions, dematerialisation through product-servicing, life cycle assessment, and cost-benefit analysis. According to Loiseau et al. (2016), however, the green economy concept seems to promise more than it can deliver. They describe it as "a way to decrease pressure on resources, climate change and emissions, while at the same time ensuring economic growth and employments" (Loiseau et al., 2016, p. 363). This makes green economy highly dependent on the success of decoupling, which poses enormous risk. Similarly, Perez (2016) sees green economy as a paradox and relates the concept to *green growth*, a way to make processes cleaner, more resource efficient and resilient, but not slowing them down. In this way, Perez argues that green growth is simultaneously being steered towards two different aims: global capitalism and sustainability.

Since the transition is not merely about solving ecological maltreatment, but to a large degree also about developing social equality, Mancebo (2015) asks for major changes in business conduct to mitigate threats both to the planet and directly to other humans (see also, Haberl et al., 2011; Louche et al., 2010). In addition, the transition comprises more than developing markets, institutions, and metrics. It raises many questions about a conceivable future society: what compromises, type of control, and validation methods a transition requires, as well as by whom and how the decisions should be made (Mancebo, 2015).

Sustainability Governance

Who shall decide, is a question of *governance*; a concept that has been used in various contexts, and in many ways, both normatively and descriptively (Kemp et al., 2005). In 1992, the World Bank defined the governance concept "as the manner in which power is exercised in the management of a country's economic and social resources for development" (World Bank, 1992, p. 1). The World Bank connects governance to sustainability already in the same publication, by stating in the Foreword that governance is needed "to promote equitable and sustainable development" (World Bank, 1992, p. v). Today, when governance aims for sustainability or sustainable development, this is emphasised by the use of the *sustainable governance* or *sustainability governance* concepts. According to many studies, sustainable governance is associated significantly (statistically) with sustainable development (Gündoğdu & Aytekin, 2022). In their study, across 149 countries, Gündoğdu and Aytekin found that good governance features like democracy, rule of law, and accountability have a direct impact on the implementation of sustainability policies. These two researchers in economics find it especially crucial to study the relationship between governance and development in relation to sustainability from a management view. Similarly, they suggest research that compares the difference in development and governance among high- and low-income countries. Kemp et al. (2005) stressed the need to involve multiple players in these processes:

> For progress towards sustainability, we need to establish governance structures and practices that can foster, guide and coordinate positive work by a host of actors on a vast complex of issues, through webs of interconnection and across multiple levels and scales … Such a conception has considerable advantages. It encompasses the multiple and diverse strengths, motives and capabilities … of the full set of public, private and civil society players, collective and individual, plus their myriad interrelations. The challenge is to achieve sufficient integration of understanding, direction and action to achieve the desired transition (Kemp et al., 2005, p. 26).

Corporate governance implies "[t]he systems of rules practices, and processes by which a firm is directed and controlled" (Chen, 2022). There is a strong relationship between the two concepts: corporate governance and CSR (Crowther & Seifi, 2021). In recent times, CSR has reached the forefront.

Corporate Social Responsibility

The concept of *corporate social responsibility* (CSR) has evolved since the mid-20th century and in the early decades it focused on labour rights, consumer safety, and environmental awareness (Carroll, 2021). Ebert and Griffin (2000, p. 83) define social responsibility as "the attempt of a business to balance its commitments to groups and individuals in its environment, including customers, other businesses, employees, and investors". Interestingly, environmental sustainability is missing from their definition. However, among the areas of social responsibility, they discuss environmental issues such as air, water, and land pollution. McWilliams and Siegel (2001, p. 117) choose a more specific standpoint when defining CSR as "actions that appear to further some social good, beyond the interests of the firm and that which is required by law." By such a definition they emphasise that CSR should transcend regulated actions and normative requirements, which means corporations must take the initiative to go beyond the minimum expectations. Idowu (2016) even proposes that advancing CSR should be the business and goal of all global citizens.

During the last three decades, the public discourse about CSR has intensified and concentrated on the interrelationship between social, environmental, and economic responsibility of businesses, also referred to as the triple bottom line (Elkington, 2018). This development in public attention shows that businesses become more active and proactive agents and promoters of sustainability transformation in social and environmental contexts. "The triple bottom line is a sustainability framework that examines a company's social, environment, and economic impact" (Elkington, 2018, p. 3), and "maintains that companies should commit to focusing as much on social and environmental concerns as they do on profit" (Kenton, 2022, n. p.). Another way to express it is through the three Ps: profit (economic value), planet (sustainability), and people (ethical leadership) (Gillis & James, 2015; Walters & Takamura, 2015). Thus, the triple bottom line is a critique against Milton Friedman's single bottom line entailing that "the sole purpose of a business is to maximise shareholder value" (Gillis & James, 2015, p. 6). Friedman was critical of the CSR concept, and meant that to be socially responsible, a firm must maximise its profit.

The person who coined the concept of the triple bottom line, wanted to recall it 25 years later (Elkington, 2018). Elkington states that their intention was not to encourage a branching into various new concepts as actually happened. Instead, they are hoping to see frameworks with a suitable pace and scale; being radical enough to change the capitalist agenda and stop the overshooting of the planetary boundaries. Therefore, Elkington argues:

> ... success or failure on sustainability goals cannot be measured only in terms of profit and loss. It must also be measured in terms of the wellbeing of billions of people and the health of our planet, and the sustainability sector's record in moving the needle on those goals has been decidedly mixed. While there have been successes, our climate, water resources, oceans, forests, soils and biodiversity are all increasingly threatened. It is time to either step up — or to get out of the way (Elkington, 2018, p. 3).

An attempt to go further from the triple bottom line, is the *quadruple bottom line*. This is a decolonising framework that searches for innovative strategies towards community development and nation building (Walters & Takamura, 2015). It unites elements that are crucial for indigenous people: community, spirituality, sustainability, and entrepreneurship, and combines these four elements to create indigenous innovation and solve challenges facing tribal nations. Similarly, Visser (2011a) argues that CSR has failed to alleviate pressing social and environmental issues. They propose that a new, improved, and systemic CSR, which they had coined *CSR 2.0* in 2008, should be based on principles of creativity, scalability, responsiveness, glocality (or global localisation), and circularity. Carroll (2021) concurs with Visser (2011b) that CSR has developed through ages of greed, philanthropy, marketing, management, and responsibility. Further, Carroll argues that "CSR 2.0 includes value creation, strong governance, societal/stakeholder contributions, and environmental integrity, with sustainable ecosystems" (Carroll, 2021, p. 1270).

Crowther and Seifi (2021), however, regard CSR as a developmental process that takes place when an organisation matures and changes the way it relates and behaves towards stakeholders and acknowledges social responsibility. Therefore, impacts of CSR on both internal and external stakeholders and shareholders are essential as they are part of the business ecosystem. Khan et al. (2021) concluded their research with managerial implications of CSR and argue that companies should satisfy CSR

> in relation to internal shareholder workers, since companies are essential in order to strengthen their well-being, concentrate on their requirements, and deliver additional instructions; in terms of external shareholders, companies must encourage the welfare of the people and lessen the adverse impact on the environment, along with producing an improved life for upcoming generations (Khan et al., 2021, p. 17).

In their discourse analysis study, Aslaksen and colleagues found that "in the long-term transformation of CSR, sustainability and environmental concerns have become more central to CSR, and that CSR discourse is increasingly merged into the sustainability discourse" (Aslaksen et al., 2021, p. 2). However, to achieve this has hitherto been all but uncomplicated. The main concern for the organisations is still the shareholders, while customers and employees, not to mention society and the environment, are less acknowledged (Crowther & Seifi, 2021). However, according to the idea of CSR, all stakeholders are important. Therefore, these shifts in the focus of CSR support the aims of this chapter; that is exploring the socio-technical transitions to sustainability and finding out how sustainability transitions can be enabled by ecosystems.

A similar concept to CSR 2.0 is *CSR 3.0*, which has only been discussed by a few authors, and lacks a clear definition, but moves towards greater collaboration by involving communities across geographical and social boundaries (Munro, 2020). Munro states that CSR 3.0 overlaps with CSR 2.0, but that it shows some indication of being a natural progression of CSR. Likewise, Munro argues that *CSR 4.0* continues to expand the scope of CSR. While the

name itself derives from the 4th industrial revolution and globalisation 4.0, Munro continues by proposing a framework for CSR 4.0 which is intended to better reflect society's demands for how companies operate in an increasingly integrated setting. The framework includes several aspects that resonate with the arguments derived in this chapter: a greater emphasis on collaborative innovation and co-creation with all stakeholders in an ecosystem, to find solutions to wicked problems.

SOCIO-TECHNICAL TRANSITIONS AND ECOSYSTEMS

Over the past century, societies have experienced unprecedented technological advancement in the aftermath of one industrial revolution and produced another. Currently, the trend is expected to continue, and a new, fourth industrial revolution is expected to take place during this century (Skilton & Hovsepian, 2018). However, technologies never act alone. Instead, they are tightly embedded and governed by the societies in which they exist. Simultaneously, technologies provide the means for societies to function the way they do. This interrelationship is the foundation for the study of *socio-technical systems*, and the transformation of such systems, that is *socio-technical transitions*, which derives from technological transitions theory (Geels, 2002). In this chapter, we propose that ecosystems are particularly suitable arrangements for innovating with the aim of inducing sustainability transitions in socio-technical systems.

Socio-Technical Systems and Sustainability Transitions

The origins of socio-technical (ST) systems relate to Kurt Lewin (1951), Eric Trist, and Fred Emery of the Tavistock Socio-Technical School and date back to the late 1950s. Drawing on open systems theory, Emery (1959) described the characteristic of the ST systems. He identified three principles of work design: 1) each part of the system embodies the overall goal of the system; 2) parts need to be self-managing in tackling problems; and 3) the members of the parts need to be multi-skilled when facing unexpected (wicked) problems. Emery underlined that only the second principle fosters adaptation to change because it allows democratisation of work through participative methods and adaptive work planning.

In recent years, ST transitions has grown exponentially in sustainability-related publications and while several models have been proposed to describe transitions, the most popular model has become Geels' intricate multi-level perspective (Hansmeier et al., 2021). In it, Geels (2002; 2019) describes socio-technical transitions as a development where innovations impact society through a process in four main phases. Phase one is experimentation and learning from trial and error at the niche innovations level; phase two is establishing a foothold in market niches; phase three is when radical innovation diffuses into mainstream markets, i.e., disrupting socio-technical systems; and phase four is when the socio-technical landscape is changed as "the new socio-technical system replaces (parts of) the old ones and becomes institutionalised and anchored in regulatory programs, user habits, views of normality, professional standards, and technical capabilities" (Geels, 2019, p. 192).

Geels (2002; 2019) distinguishes the ST landscape (i.e., external societal context) from ST regimes (i.e., rules in different social groups, later called ST systems) and points out that changes, like ST transitions to sustainability, take place more slowly in the ST landscape

than in ST regimes/systems. Furthermore, Geels argues that ST regimes are made up of various dimensions: 1) technology; 2) user practices and application domains (markets); 3) symbolic meaning of technology; 4) infrastructure; 5) industry structure; 6) policy; and 7) techno-scientific knowledge (Geels, 2002, p. 1262). In this chapter we argue that ecosystems provide a theoretical structure for the interplay between these dimensions, and for the transdisciplinary collaboration and co-creation needed for ST transitions targeting global challenges. In the sustainability transitions literature, the multi-level perspective has been a popular theory for gaining insight into the dynamics of transition processes in the context of sustainability efforts (Markard et al., 2012; Vähäkari et al., 2020). Vähäkari et al. consider it particularly suitable for providing multiple levels of analysis and assuming long time horizons. Therefore, the multi-level perspective provides an established theory for describing the process by which innovation activities enable sustainability transitions facilitating wider changes in societies, such as a sustainability transformation.

Ecosystems and Innovation

So far, we have argued for the need to include businesses when looking for solutions to global challenges, and that greater collaboration and networks among all stakeholders is increasingly necessary to meet the needs of societies. The multi-level perspective draws attention to the complex socio-technical processes that influence transitions towards more sustainable solutions. Critical issues in such processes relate to inducing and sustaining effective collaboration among multiple stakeholders in a manner that steers innovation activities towards shared, sustainability-focused objectives. Based on the emerging literature on *ecosystems*, we explore the potential benefits and challenges of ecosystems as a way for organising innovation activities to support sustainability transitions.

The ecosystem concept originates in biology, in which it refers in coarse terms to communities or assemblages of biological entities and their environment (e.g., Pickett & Cadenasso, 2002). In management research, the ecosystem concept has brought attention to the flows and interdependencies among organisations, extending beyond industry-specific supply chains to providers of complementary products, competitors, customers, regulators, and so on (Iansiti & Levien, 2004; Moore, 1993). In management literature, the ecosystem concept has been used in various ways and at different levels of analysis, for example, to refer to geographically co-located firms (Korhonen, 2001), focal firms, and their suppliers and complementors (e.g., Adner, 2006; 2017), technology platforms (Gawer, 2014), clusters of entrepreneurial or research activity (Autio et al., 2018; Järvi et al., 2018), or entire industries (Ansari et al., 2016; for a more comprehensive review, see Thomas & Autio, 2020).

Management literature presents distinct definitions of ecosystems (Shipilov & Gawer, 2020; Thomas & Autio, 2020). In general, this literature defines ecosystems as sets of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled (Jacobides et al., 2018). Besides this general definition, the literature also draws distinctions between business, innovation, and platform ecosystems. *Business ecosystems* refer to communities of organisations, institutions, and individuals that impact a focal firm and its customers and supply chain (Teece, 2007), thus pointing to broad and fluid arrangements around focal companies and their business activities (Thomas & Autio, 2020). *Innovation ecosystems*, in turn, emphasise the ecosystem-level output created by collaborating actors, and "the alignment structure of the multilateral set of partners that need to interact in order for

a focal value proposition to materialize" (Adner, 2017, p. 42). Finally, *platform ecosystems* are innovation ecosystems that focus on the technological interdependencies among collaborating actors, with emphasis on technological architectures (e.g., a digital platform or marketplace) as the alignment structure for realising a system-level output.

To reconcile the discourses on various ecosystem concepts in management, the literature points to at least three defining characteristics that are important for understanding innovation in ecosystems. First, as indicated above, ecosystems typically refer to collaborative constellations comprising heterogeneous actors across industrial boundaries in the creation of a joint, system-level output or value proposition (Adner, 2006; Thomas & Autio, 2020). Thus, ecosystems draw attention to collaborative innovation and business activities that provide more value for customers (and as a result, competitive advantage to ecosystem participants) due to the joint outputs the ecosystems facilitate (Moore, 1993). Second, ecosystems leverage the multilateral and non-generic complementarities of collaborating actors (Jacobides et al., 2018). Non-generic complementarities refer to resources and competencies that are specific to the system-level solution. Thus, such resources and competencies cannot be easily acquired from markets, but they develop over time as actors co-evolve and co-specialise their resources and competences to materialise the system-level output (Thomas & Autio, 2020). Third, ecosystems employ a distinct mechanism of coordination for collaborative innovation and business activities that is based on non-hierarchical control (Shipilov & Gawer, 2020). Instead of tight contractual relations or free market arrangements, ecosystems are built around system-specific alignment structures – such as modular ecosystem roles – that coordinate joint activities in a distributed manner (Adner, 2017). This means that ecosystems simultaneously direct actors to specialise in their ecosystem role while simultaneously retaining the control of actors' resource deployment decisions (Jacobides et al., 2018).

Ecosystems research complements many other fields in the field of management, as it focuses on the complex dynamics behind the emergence of collective action (Thomas & Ritala, 2022). Over time, the collective actions bind the actors through multiple mechanisms, such as the non-redeployability of their collective investments elsewhere (Jacobides et al., 2018), complementarities and interdependencies between actors (Kapoor, 2018), or the alignment structures that facilitate interactions and access to collective benefits for the actors involved (Adner, 2022). Hence, the ecosystem – the roles, positions, and flows between its actors – becomes defined through the activities performed by its participants (Adner, 2017; 2022). In other words, ecosystems require dynamic, adaptive governance mechanisms to sustain value creation over time (Cennamo & Santaló, 2019).

Such dynamism implies particular challenges to the management or orchestration of ecosystems. Traditional management thinking would advise that in conditions of high environmental uncertainty, relationship-specific investments, and multiple transactions, the companies should insource more operations (Williamson, 1985) instead of looking for external partners (Kohtamäki et al., 2019). The issue often relates to the difficulties of defining the interaction, its outcome, or reward obtained ex ante, making it difficult or even impossible to rationalise whether a specific actor should partake in the collective activity. This can have a negative effect on ecosystem formation and success, for instance, by reducing the likelihood of investing in enabling technologies (Teece, 2018), limiting the success of industry platforms (Gawer & Cusumano, 2014), or balancing between openness and governance in meta-organisations (Gulati et al., 2012).

Relatedly, as Dattée and colleagues (2018) have pointed out, it has often been assumed that the result of an ecosystem can be defined ex ante, by setting a compelling blueprint for the future (Dattée et al., 2018). Such thinking illustrates the negligence of the dynamic nature of ecosystems. Many fundamental premises of the ecosystem, such as the need for alignment between partners (Adner, 2022), focus on technological (Shipilov & Gawer, 2020) or cognitive interdependencies (Thomas & Ritala, 2022), among many other things, ultimately bind the members of the ecosystem together (Jacobides et al., 2018). However, the assumption that the output of the ecosystem or the outcome for a certain member exhibits linear, near-deterministic tendencies of the management literature (Dattée et al., 2018), largely overlooks the challenges associated with the uncertainties of the collective action at the heart of the ecosystem (Thomas & Ritala, 2022). The unpleasant truth of ecosystems is that the outcome of even the best of plans can only be seen ex post. As will be discussed in more detail in the next section, these issues also pose challenges to ecosystems geared to the development of sustainability-oriented system-level solutions.

ECOSYSTEMS AS INNOVATORS FOR SUSTAINABILITY TRANSITIONS

Besides shedding light on ecosystems as a distinct form of coordination, and the outcomes ecosystems enable in terms of both new customer-facing solutions and competitive advantage for participating actors, the ecosystem concept can provide insight into the present discussion on sustainability transitions in two ways. First, sustainability transitions call for new forms of collaboration to allow the development of system-level sustainability-improving solutions (e.g., Adams et al., 2016; Markard et al., 2012). Here, ecosystems can provide a way to organise and govern such activities in different spheres of innovation activity, from loose knowledge and entrepreneurial ecosystems focused on early research and development and commercialisation activities, to solution-specific innovation and business ecosystems geared towards the development and realisation of a novel value proposition (e.g., Adner, 2017; Järvi et al., 2018; Thomas & Autio, 2020). In particular, ecosystems are potential loci for the emergence of not only new technological solutions, but also prototypical industry architectures and institutional arrangements within which new (and more sustainable) forms of value creation can emerge and be scaled up (e.g., Jacobides et al., 2006), thus influencing the wider industry and society (e.g., Garud & Karnøe, 2003; McMeekin et al., 2019).

Second, the challenges in simultaneously orienting collaborative activities towards economic, social, and/or environmental objectives call for new forms of coordinating and governing collaborative innovation and business activities (e.g., Margolis & Walsh, 2003). In this situation, the non-hierarchical forms of coordination and governance characteristics of ecosystems can support the co-specialisation needed to materialise system-level objectives and create structures that facilitate the scale-up of such solutions over time. For instance, studies in the context of circular economy draw attention to several types of ecosystems that can support more sustainable forms of production, knowledge creation, and business activity (Aarikka-Stenroos et al., 2021). For instance, this work draws attention to ways in which regional co-location and co-specialisation can enable the use of industrial side-streams, or recycled materials, in production processes, and the ways in which universities, research

institutions, and entrepreneurial communities can accelerate knowledge-sharing around the commercialisation of technologies and scaling up new business models.

Additionally, we present three research avenues arising at the intersection of ecosystems and broader sustainability transitions. First, ecosystem emergence for sustainability-oriented solutions is a critical issue for both ecosystems at large, and for sustainability-oriented ecosystems in particular. As discussed above, a challenge in the formation of ecosystems is the need for resource co-specialisation, which requires investments by ecosystem participants in system-specific technologies and knowledge production. At the same time, the returns of those investments are uncertain as revenues accrue over time with the scale-up of the system-level solution (Jacobides et al., 2018), potentially limiting the willingness of participants to invest in ecosystem-specific resources that are difficult to deploy elsewhere (Teece, 2018). Furthermore, ecosystem emergence is an iterative process, characterised by uncertainty with respect to the complex interdependencies among actors and the generative potential of such interdependencies in creating system-level solutions (Dattée et al., 2018). Therefore, it is difficult to create momentum for the initial ecosystem formation. Sustainability-oriented solutions amplify these issues as the benefits sought by ecosystem actors are simultaneously oriented to economic, social, and environmental benefits. One avenue for approaching these issues, and their resolution in sustainability-oriented ecosystems, is to study the critical processes that legitimate emerging ecosystems by making them socially acceptable and desirable constellations for pursuing system-level objectives (Thomas & Ritala, 2022). For instance, future research could explore the role of ecosystem orchestrators, as well as other actors, in giving meaning to, and shaping, the identity of the ecosystem around sustainability. Research is also needed to study how key actors can demonstrate the viability of the system vis-à-vis economic and sustainability objectives.

Second, the stabilisation of sustainability-oriented ecosystems and the scale-up of their system-level solutions remains uncertain. This question is particularly relevant for understanding the role of ecosystems in broader sustainability transitions, and the mechanisms through which they can transform technological, market, social/symbolic, regulatory, and scientific processes that comprise socio-technical systems. For instance, the creation and scale-up of new business models can be one mechanism through which ecosystems induce change. This occurs by allowing ecosystem actors to become autonomous from existing regimes in the creation of a new structure for value-creating activities, or by inducing a gradual change in the functioning of the existing regime (e.g., Bidmon & Knab, 2018; Bolton & Hannon, 2016). Alternatively, ecosystems can co-create new technologies and technological architectures or infrastructures that induce a gradual shift, such as when modular technological solutions enable a gradual transition from fossil to low-carbon energy production or transport (e.g., McMeekin et al., 2019). When considering a specific ecosystem, such questions are intertwined with the internal ecosystem dynamics, such as clarification of interdependencies, sharing of accountability for sustainability outcomes, and distribution of economic benefits (e.g., Dattée et al., 2018). Thus, more focused research is needed to understand the intersection, and boundaries, between specific, local ecosystems and broader transition dynamics.

Third, many popular change management models assume that the desired outcome is understood or perhaps even known (cf. Galli, 2018). This is not the case with wicked problems, when intricate systems dynamics may cause seemingly desirable steps to cause new problems, all but eliminating the benefits achieved. In the discourse on mission-oriented innovation, Mazzucato (2018) argues that past innovation projects, attempting to solve

complex challenges, have been successful when the transformation needed was well defined in advance. They imply that this is a key reason for why humans have been more successful at achieving technocentric missions, like putting a man on the moon, than at mitigating global crises, like poverty and climate change. As explained earlier in this chapter, ecosystems seem to be particularly unsuitable for achieving pre-set targets, because both the ecosystem and its value proposition are typically defined ex post. This could partly be explained by a lack of ownership for the ecosystem's value proposition. Such a proposal would tie into the tragedy of the commons dilemma and propose that ecosystems research should connect with governing the commons, a topic introduced by Ostrom in 1990, and which since then has grown into a major research field and movement (Van Laerhoven et al., 2020). Wolff and Hakanen (2021) propose that design may offer solutions to ecosystem co-creation. However, as we have described, the ecosystems literature indicates that this is only viable when design processes are used to support explorative innovation practices. We accept that there may be several more unmentioned systemic challenges to successful innovation in ecosystems, which may ask for a thorough comparative study of failed and successful innovation projects in ecosystems.

Next, we present a case from the field of urban mobility to illustrate some of the challenges we mentioned in relation to ecosystems facilitating collaborative and co-creative innovation activities across boundaries and attempting to enable sustainability transitions. One decade ago, the concept Mobility as a Service (MaaS) was presented as a novel service system which would transform urban mobility by changing commuter behaviour, increasing accessibility across demographics, and reducing the overall environmental impact of urban mobility (Hensher et al., 2020). In other words, the aim of the innovation was, from the very beginning, to produce a sustainability transition. Wolff and Hakanen (2021) argued that MaaS itself accurately defines an ecosystem as it demands that mobility services are restructured and that the products provided by each business in the ecosystem are traded freely. However, the development of such an innovative service has been hampered in several of the regions in which it was introduced. The reasons behind the slow progress are still debated, but the incumbents seem to have resorted to protectionism – potentially because of the lack of ownership, or the potential shift in ownership proposed by MaaS (Wong et al., 2020). While the ecosystem has been lacking investments into enabling technologies, governments have been unable to envision how to enable a transition in the highly regulated field of mobility (Wolff & Hakanen, 2021). In this example, the public sector has been involved from the very beginning, but being themselves in the role of transportation provider, they have functioned as both policymaker and industry incumbent. Therefore, it cannot be assumed that other ecosystems are bound to face the same challenges, considering that the roles of all members may be clear and interests easier to anticipate.

Several scholars (e.g., Aslaksen et al., 2021; Munro, 2020) have argued that CSR requires companies to increase the strategic importance of social and environmental success to complement profit-making in line with the triple bottom line. They also call for increased collaboration between sectors and stakeholders, as described by the CSR 2.0 and 3.0 concepts (Munro, 2020). Carroll (2021) calls for strong governance and stakeholder contributions. However, while these statements demand that companies direct serious interest towards a new purpose, the question of how these collaboration activities should be governed remains unanswered. Thus, in the context of innovation ecosystems, further research is needed to investigate the formal and informal governance structures, as well as the use of tools such as intellectual property rights (IPRs), that are needed to balance economic, social, and environmental objectives

in collective innovation efforts. Literature shows a growing interest towards pragmatism as a means to respond to the failed efforts to solve urgent global challenges. As argued by Farjoun et al. (2015, p. 1798–1799) "Pragmatist principles are particularly relevant for dealing with the contemporary challenges of change and complexity across multiple levels of analysis." However, as pragmatism advocates focusing on known problems or needs, it may also present a conflict with ecosystems – unless they allow themselves to be governed. In management literature, ecosystems seem to have been presented as inherently non-pragmatic. Therefore, future research should explore whether pragmatism would provide new solutions for dealing with ecosystem challenges.

CONCLUSION

In this chapter we first argued that the current discourse on sustainability governance and CSR presents a pressing need for collaboration and co-creation across geographical and socio-economic boundaries. We explained how ecosystems offer a theoretical basis for transdisciplinary collaboration when conducting innovation activities, and we discussed the challenges and benefits related to ecosystems as a form of organising. Through this elaboration, we have answered the research question: How do ecosystems facilitate innovation activities that enable sustainability transitions? We argue that ecosystem theories present a clear and suitable strategy for organising the collaborative innovation activities that are needed in responding to global challenges. We also identify several challenges in leveraging ecosystems for sustainability transitions. To address these challenges, future research is needed particularly on the governance of ecosystems, whether and how ecosystems can form around a shared, sustainability-oriented mission, as well as how the development of ecosystems can be supported over time.

This chapter contributes to management theory by examining the connection between ecosystems, innovation, and requirements defined by sustainable development targets. Additionally, this chapter contributes to sustainability transitions theory by examining how ecosystems offer promising potential for enabling transdisciplinary collaboration. Furthermore, we have shown that the discourses on sustainability governance and CSR both support the use of ecosystems when conducting innovation activities. This chapter calls for practitioners to continue their efforts to increase collaboration and co-creation in innovation activities. However, it is demanding to stop a mischievous development, to heal and rebuild a damaged planet, and to recognise all humans as equal. To reverse the present trajectories of climate change and other ecological crises, and to improve the living conditions for the global population, ecosystems offer means for collaborative actions in tackling these global challenges. However, new forms of collaboration must couple with changes in the values and expectations the society imposes on companies and other actors, as well as regulation that not only recognises but takes seriously the fair treatment of both present and future generations and the planet.

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NOTE

1. Joel Wolff coordinated the definition of the research question and the selection of concepts under study. He also led the writing and the detailing of the aim, scope, key arguments, and structure of the paper. Maria Jakubik contributed to clarifying the concepts, developing the main research question, and participated in writing mainly the section on the role of business and the one on socio-technical systems. Jaakko Siltaloppi contributed to critically evaluate and structure the discussion about ecosystems in relation to the other concepts in this chapter, and as such participated in writing mainly the sections on transitions and ecosystems. Lili-Ann Wolff participated mainly in writing the section Global Challenges and the Role of Business. Esko Hakanen participated mainly in writing the sub-section Ecosystems and Innovation. All authors participated in discussions about the scope, structure, and aim of this chapter, as well as in establishing the concepts and arguments relevant for this study.

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