



Enhancing systems thinking in corporate sustainability through a transdisciplinary research process

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ABSTRACT

Sustainability is no longer a peripheral topic for most corporations, as they increasingly adopt more proactive business strategies. In spite of this, there has not been sufficient positive change in corporate practice and research indicates that our ecosystems are continuing to deteriorate at an alarming rate. In this study, we analyse the extent to which social-ecological systems (SES) thinking can be used as a bridging concept in transdisciplinary sustainability research, in order to improve corporate sustainability practices. We draw on a case study of the Business Forum in the Sustainable Market Actors for Responsible Trade (SMART) project. The data was collected from two workshops, semi-structured interviews with corporate representatives, and autoethnographic accounts. Our findings show that a successful transdisciplinary research process requires both significant interest and capacity to act on the part of corporate representatives. Enabling factors for such collaboration are mutual understanding of concepts and having sufficient time to invest in the collaboration. We suggest that risk management can be used as a conceptual metaphor to translate SES thinking in order to make it more relevant in the context of corporate practice. On this basis, we conclude that SES thinking indeed can be used as a bridging concept in transdisciplinary research collaboration for corporate sustainability.

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1. Introduction

Today corporations engage in multiple aspects of the sustainability challenge and use more proactive business strategies (e.g. Berger et al., 2007; Smith, 2010; Bansal and Hoffman, 2011; Hart and Dowell, 2011; Whiteman et al., 2013). Companies have to a certain extent learnt to adapt and innovate their business practice by shaping new strategies and business models that are fit for the future (Folke et al., 2019). However, at the same time, corporations are on the whole increasingly leveraging their global power, exploiting natural resources and local communities, to the extent that 'only a handful of transnational corporations have become a major force shaping the global intertwined system of people and planet' (Folke et al., 2019, p. 1396). We call this the 'corporate-

ecological disconnect'.

There is furthermore also a disconnect between corporate sustainability research and macro-level ecosystem process (Kallio and Nordberg, 2006; Levy, 1997; Levy and Lichtenstein, 2011; Walker et al., 2009; Whiteman et al., 2013; Dahlmann et al., 2019). Thus, social-ecological systems (SES) thinking, a research approach for understanding cross-scale dynamics of social practices and ecosystems, provides a useful lens for analysing sustainability challenges (e.g. Berkes et al., 1998; Berkes et al., 2003; Carpenter et al., 2012). This perspective sees humans as both part of, as well as being able to shape, the ecosystems that they depend on (e.g. Liu et al., 2007; Folke et al., 2016; Norström et al., 2017). From a corporate perspective, this means recognising that business activities depend on and are embedded in the natural environment (Gladwin et al., 1995; Roome, 2012; Starik and Rands, 1995; Whiteman et al., 2004; Williams et al., 2017). However, SES research on corporate perspectives are mainly theoretical and lack insights into how different groups of actors, including academics and managers, can co-create transdisciplinary knowledge to remedy the 'corporate-ecological disconnect'.

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Transdisciplinary approaches focusing on societal problems involve mutual learning and generate solutions-oriented knowledge that is relevant for all actors (e.g. Gibbons, 1999). In guiding our research, we define transdisciplinarity as ‘a reflexive, integrative, method driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge’ (Lang et al., 2012, p. 26–27). In this study, we put an emphasis on the co-production of knowledge, defined by Knapp et al. (2019, p. 2) as ‘a process of knowledge creation attuned to both local (sharing knowledge) and larger (influencing governance structures to facilitate it) problem-solving’ (see also Kates et al., 2001).

According to Deppisch and Hasibovic (2013), SES thinking is well-positioned to act as a bridging concept between different scientific disciplines and practitioners due to its broad scope, focus on solving real-world problems, and integration of natural and social science. This approach was found to open up the discussion, which enabled joint creative work. This made it possible to together define the problem and select appropriate variables for examination (Deppisch and Hasibovic, 2013). Consequently, SES thinking is a conceptual framing in transdisciplinary processes that connects academic and practitioner domains. While SES thinking has already been referenced in corporate sustainability research, the field could benefit from more transdisciplinary research (Starik and Rands, 1995; Whiteman et al., 2013; Williams et al., 2017). At the same time, there are few examples of effective application of inter- and transdisciplinarity in research projects (von Wehrden et al., 2019). Considering this gap and the urgency of the corporate-ecological disconnect, the goal of this study is to *analyse to what extent SES thinking can be useful as a bridging concept in the transdisciplinary research on corporate sustainability, with the aim of improving corporate sustainability practices.*

The paper is organised as follows: In section 2, we present our methodological approach to transdisciplinary research collaboration including the research process, data collection and data analysis. In section 3, we introduce transdisciplinarity as the conceptual framework. In section 4 we present our findings that consist of an application of the framework developed by Lang et al. (2012). In section 5 we discuss the main findings, and section 6 concludes.

2. Methodological approach

In this section we describe our methodological approach in three steps: (1) the research process, (2) data collection, and (3) data analysis.

2.1. Research process

We draw on a case study of the Business Forum in the Sustainable Market Actors for Responsible Trade (SMART) project that brought together academics and practitioners to co-create knowledge for integrating SES thinking into corporate sustainability practices. The aim of the SMART project is to ‘identify the barriers and drivers for market actors’ contribution to the United Nations Sustainable Development Goals within planetary boundaries, in order to achieve policy coherence for development’ (SMART, 2019a).

In order to analyse the usefulness of SES thinking as a bridging concept in corporate sustainability research, we have applied the transdisciplinary research process framework developed by Lang et al. (2012) to design the corporate-academic collaboration in the SMART Business Forum (SMART, 2019b). By applying the framework to the SMART Business Forum case study, we aimed to gather further and more granular insights into the transdisciplinary

research process. More specifically, we used a ‘revelatory single case study design’ (see Yin, 2017, p. 50) as the context of the SMART Business Forum enabled access to multiple corporate representatives’ perspectives on corporate-academic collaboration and corporate sustainability practices.

2.2. Data collection

We collected qualitative data from four sources: (1) audio recordings from the workshop *Integrating systems thinking in corporate sustainability*¹ (Workshop 1) in 2018, (2) field notes taken during discussions at Workshop 1 and *Business model change: Actions following COP24 and the 2030 Agenda*² (Workshop 2) in 2019, (3) autoethnographic accounts (see Ellis et al., 2011), and (4) semi-structured interviews with corporate representatives. In order to stimulate discussion and facilitate co-production of knowledge, we prepared guiding questions (see *Supplementary Materials, Table S1*). The guiding questions were informed by the first workshop’s aim of creating a process of ‘mutual learning and exchange of knowledge’ (see Lang et al., 2012, p. 26; von Wehrden et al., 2019, p. 882 on the process of creating a collective glossary in transdisciplinary research). The field notes were taken during the two workshops and amounted to 25 pages overall. The first co-author wrote a retroactive narrative ethnography about her experience prior to and during the workshops. Such ethnographic accounts in the form of a narrative can capture rich details about the researcher’s experiences, including interactions with other workshop participants (see Ellis et al., 2011).

We supplemented the data from the workshops with five semi-structured interviews, conducted with workshop participants. The interviewees were asked the same questions, although we allowed for some flexibility, which enabled us to alter the sequence of the questions and ask additional follow-up questions (see N. Fielding, 1993b). These were conducted in the autumn of 2018 and lasted for approximately 1 h each. The audio recordings were transcribed.

2.3. Data analysis

We coded the interview data and the transcripts from the workshop by developing abstract categories and thereafter typologies of significant findings (see J. Fielding, 1993a) so that we could compare the data with key concepts and phases from the applied conceptual framework (Lang et al., 2012).

The lead author coded all the interview and workshop transcripts. We used the field notes and autoethnographic narratives as descriptive material to help us understand the context of the case and research process over time. The interview and workshops audio files were transcribed verbatim. For the analysis we started with a list of predefined codes developed from three main sources: (1) the transdisciplinary research process (see Lang et al., 2012) such as problem framing, co-production of knowledge, participation, and mutual learning processes, (2) diverse knowledge system integration (see Tengö et al., 2014 and section 3 below), and (3) codes developed from the questions for Workshop 1 (see *Supplementary Materials, Table S1*).

The data was coded using an iterative approach (Loftland et al., 2006; Whiteman and Cooper, 2016) and the lead author moved back and forth between the data and the transdisciplinary research literature. The codes were then adjusted accordingly through

¹ See workshop descriptions here: <http://www.smart.uio.no/events/events/integrating%20systems-thinking%20in%20corporate%20sustainability>.

² See workshop descriptions here: <https://www.smart.uio.no/events/events/20190204-business-model-change.html>.

Table 1
The transdisciplinary research process from Lang et al. (2012).⁴

Societal practice	Transdisciplinary research process		Scientific practice
Social problems <ul style="list-style-type: none"> • Everyday life relevant • Actor specific 	Phase A	Problem framing/Team building	Scientific problems: <ul style="list-style-type: none"> • Uncertainty • Lack of methods • Disciplinary specialisation • Generalisation
Actor specific societal discourse <ul style="list-style-type: none"> • Administration • Institutions • NGOs • Corporations • Politics • Media 	Phase B	Co-creation of solution-oriented transferable knowledge	Scientific discourse: <ul style="list-style-type: none"> • Institutions of higher education • Non-university research • Industrial research
Results useful for societal practice <ul style="list-style-type: none"> • Strategies • Concepts • Measures • Prototypes 	Phase C	(Re-)Integration and application of created knowledge	Results relevant for scientific practice: <ul style="list-style-type: none"> • Generic insights • Methodical and theoretical innovations • New research questions

intuition from the data (see J. Fielding, 1993a). For example, the concept of a 'continuum between risk and opportunity' emerged as important due to the concept of risk being such a multifaceted and important concept in corporate governance, as well as in corporate sustainability. This ultimately resulted in three main themes and four explanatory factors that explain how SES thinking can be used as a bridging concept with the support of the concept of risk (see Table 3). These are presented in Section 4.

3. Conceptual framing

3.1. Transdisciplinary and sustainability research

Sustainability problems are complex, multi-faceted, and span interconnected economic, social, and environmental domains. In order to solve such problems, vital knowledge from all relevant actors and disciplines needs to be included (Lang et al., 2012, p. 26). Benefits stemming from the integration of knowledge systems across different communities include enhanced ecosystem governance, innovation, and novel insights (Tengö et al., 2014). For this reason, research collaborations should involve transdisciplinary approaches. Multi-actor collaboration is generally seen as a necessary approach to address sustainability challenges and to develop solutions (Lang et al., 2012). This means creating 'participatory procedures involving scientists, stakeholders, advocates, active citizens, and different users of knowledge' (Kates et al., 2001, p. 641).

There are many research practices that involve diverse actors, including transdisciplinary, community-based, interactive, or participatory approaches (see e.g. Kasemir et al., 2003; Savan and Sider, 2003; Robinson and Tansey, 2006; Hirsch Hadorn et al., 2006; Jahn, 2008; Scholz et al., 2006; Scholz, 2011). Two common approaches to integrating research and practice are, first of all, using the input from laypersons in scientific research while maintaining the 'primacy of science', and secondly using research as input in decision support, ensuring the 'primacy of practice'. From time to time there may be clear power imbalance or epistemological differences. In such cases, 'it is important to differentiate between (a) integration of knowledge, (b) parallel approaches to

developing synergies across knowledge systems, and (c) co-production of knowledge' (Tengö et al., 2014, p. 582).³ It is similarly important to distinguish transdisciplinary research from both the primacy of science and practice (Robinson, 2003; Bergmann et al., 2005). This, in effect, means not accepting the hierarchical superiority of either academics' or practitioners' knowledge, but rather focusing on the interesting co-benefits of how each complements the other.

Transdisciplinary approaches aim to create an equal and shared space for interaction, dialogue, and clarification possibilities (Ellingsen, in press). This means respecting and including all research participants' opinions, in order to engender trust and better cooperation as a result (von Wehrden et al., 2019). However, tensions may arise in the transdisciplinary process due to diverging goals of the various actors involved. Such tensions necessitate negotiation and mediation, which are not conventional research tasks. This, as a result, could make researchers engaging in transdisciplinary research collaboration somewhat uncomfortable or feel that what they are being asked to do is inconsistent with what scholarship should entail (Ezrahi, 1990). In return, practitioners may view the collaboration as burdensome in terms of the time they are required to invest in such practice. In the worst case, they may even perceive the collaboration as affecting their autonomy or independence (Ezrahi, 1990). One strategy to overcome tension between the actors is to establish experience-based guidelines (Lang et al., 2012). Those guidelines need to be accepted by all actors involved and be based on demonstrated success stories (see Cash et al., 2003). Overall, despite the challenges of conducting transdisciplinary research, benefits with collaboration between researchers and practitioners include increase in legitimacy, notions of ownership and accountability for solving the problem that is being addressed (Funtowicz and Ravetz, 1993; Gibbons et al., 1994; Hirsch Hadorn et al., 2006; Baumgärtner et al., 2008; Talwar et al., 2011; Spangenberg, 2011; Lang et al., 2012).

³ While Tengö et al. (2014) elaborate around connections and synergies regarding traditional, local and 'scientific' knowledge, we use this conceptualisation when analysing corporate-academic collaboration.

⁴ This is the conceptual model of an ideal-typical transdisciplinary research process developed by Lang et al. (2012, p. 28) and is here used with the permission of Springer Nature. The model was adopted from Bergmann et al. (2005); Jahn (2008); Keil (2009); Bunders et al. (2010). It needs to be acknowledged that there are other similar models that have conceptualised transdisciplinary research processes: e.g., Scholz et al. (2006); Pohl and Hirsch Hadorn (2007); Carew and Wickson (2010); Krütli et al., 2010; Stokols et al. (2010); Talwar et al. (2011).

Table 2
The transdisciplinary research process guided by the research process set out by Lang et al. (2012).

Societal practice	Transdisciplinary research process	Scientific practice
<p>Social problems: <i>Unsustainable corporate practice</i></p> <ul style="list-style-type: none"> • The 'corporate-ecological disconnect' • Lack of large-scale, timely, transformative corporate action • Limited appreciation of the complexity of sustainability 	<p>Phase A Problem framing/Team building: <i>SMART Business Forum</i></p> <ul style="list-style-type: none"> • Workshop: <i>Integrating systems-thinking in corporate sustainability</i> • Establishment of the SMART Business Forum and affiliated events → Hypothesis: SES thinking may be translated through processes of risk 	<p>Scientific problems: <i>Mismatch between academic advice and practical implementation</i></p> <ul style="list-style-type: none"> • Lack of understanding of macro ecological processes in corporate sustainability research • Lack of academic competence that generates practical application
<p>Actor-specific societal discourse: <i>Purpose of the corporation</i></p> <ul style="list-style-type: none"> • Rational actors (e.g. what is the added value of sustainability action?) • Sectoral specific solutions • Post CSR efforts with main emphasis on finance • Shareholder maximisation norm (if applicable) 	<p>Phase B Co-creation of solution-oriented transferable knowledge <i>Initiation of small sub-team of the SMART Business Forum to plan workshops</i></p> <ul style="list-style-type: none"> • Workshop: <i>Integrating systems-thinking in corporate sustainability</i> • Workshop: <i>Business model change: Actions following COP24 and the 2030 Agenda</i> 	<p>Scientific discourse: <i>Corporate misunderstandings of sustainability</i></p> <ul style="list-style-type: none"> • Integrate SES thinking (e.g. Berkes et al., 1998) in corporate practice • Barriers to organisational change (such as current corporate 'business-as-usual' cultures, based on neoliberalism). This needs to go beyond technological or managerial systems changes (see Lozano, 2012).
<p>Results useful for societal practice: <i>Conceptual discussions on language the implications of SES as a bridging concept</i></p> <ul style="list-style-type: none"> • A trans-disciplinary research method where an emphasis of co-production of results and trust is successful in creating a good environment and starting point for collaboration. • There is untapped potential for corporate-academic collaboration where the latest research can be applied in practice. • Reluctance towards applying complex framework in corporate sustainability practices can be partly bridged through a joint discussion beyond the 'primacy of science', and the 'primacy of practice'. • SES thinking may be translated through processes of risk management. 	<p>Phase C (Re)-Integration and application of created knowledge: <i>Initiation of the SMART Pilot programme</i></p> <p>The SMART Pilot Projects are designed for businesses who wish to implement the SMART Sustainable Governance Model (SGM) and Sustainability Assessment Tool (SAT) (see Sjöfjell and Muñoz Torres, 2019). The SMART SGM aims to (re)shape a business so that it contributes to sustainability. It requires high-level commitment in the company, strategy implementation, integration and continuous follow-up. This involves in the default version the following steps:</p> <ol style="list-style-type: none"> 1. Select the starting point: company, corporate group, business area, or project. 2. A commitment on the highest possible level to sustainable value creation within planetary boundaries. 3. Select scope of the company's energy use and emissions to be included and the tiers that are to be included of the global value chain. 4. A research-based and stringent assessment process using the SMART SAT. 5. A continuous improvement process. 	<p>Results relevant for scientific practice: <i>Practical (limited) possibilities in applying scientific concepts</i></p> <ul style="list-style-type: none"> • A transdisciplinary research method where an emphasis of co-production and trust is successful in creating a good environment and starting point for collaboration. • Crucial to develop methods that encapsulate complexity but are simple enough for corporate reality • It is useful to apply the conceptualisations of integrating different knowledge systems elaborated by Tengö et al. (2014) when applying the methodological framework by Lang et al. (2012).

3.2. The transdisciplinary research process

In this study, we apply the transdisciplinary framework developed by Lang et al. (2012) that identifies three phases of transdisciplinary research. In **Phase A**, researchers and practitioners collaboratively frame the sustainability problem and build a joint research team. Then in **Phase B**, the research team co-creates and transfers solution-oriented knowledge. Finally in **Phase C** the research team reintegrates and applies the solution-oriented knowledge. **Phases A-C** are summarised in Table 1.

Lang et al. (2012, p. 29–35) recommend design principles that cut across **Phases A-C**. One of those design principles is to 'enhance capabilities for and interest in participation' (Lang et al., 2012, p. 35). In order to do so, they recommend the following tactics: choosing meeting facilities that are accessible, considering the date and time that most participants can participate, considering which languages to use, and planning for interactive meetings (Lang et al., 2012, p. 35). This allows participants to communicate their perspectives, have meaningful discussions, deliberations, and negotiations (Stokols et al., 2010, p. 476–477; see also Stokols et al., 2008).

4. Findings

We present our findings in chronological phases. In **Phase A**, problem framing and team building was undertaken through the initiation of the SMART Business Forum. In **Phase B**, the process of co-creation of solution-oriented transferable knowledge, we established two sub-teams that planned and executed two workshops. **Phase C**, the phase for re-integration and application of the created knowledge, is yet to be initiated but we are seeking to begin pilot projects with companies, as part of the legacy of the SMART project (SMART, 2019c).⁵ The emergent process of how we applied the framework by Lang et al. (2012) is summarised in Table 2.

4.1. Phase A: problem framing

4.1.1. Idea formation

The idea of organising Workshop 1 stemmed from the first co-author's frustration with the lack of corporate progress, self-experienced barriers to integrating SES thinking in corporate

⁵ It is expected that this work will be published after the SMART project is completed on 29 February 2020.

practice, as well as curiosity with regard to what could be done to tackle the 'corporate-ecological disconnect'. This guided the process of designing a workshop where academics and practitioners met and co-produced propositions on how to further the process of integrating SES thinking into corporate sustainability practice.

4.1.2. Forming the team

Frustration regarding the lack of progress in corporate sustainability practice brought co-author 1 and 2 together (see *Supplementary Materials*, Table S3). We started to sketch the design and the content of the workshop. Very soon, we came to realise that it was necessary to include a corporate representative into the process of developing the workshops. Consequently, we contacted a Senior Principal Scientist that has an academic background from a company with expertise in the area of SES and resilience thinking and sustainability management research. She agreed to take part in planning the workshop and subsequently participating in it.

As indicated in Table 2, the workshop *Integrating systems-thinking in corporate sustainability* in January 2018, initiated the establishment of the Business Forum within the SMART project. Workshop 1 brought together 13 participants from 12 organisations or businesses and represented the fulfilment of the first main component of members in our Business Forum. Workshop 2 on the topic of *Business model change: Actions following COP24 and the 2030 Agenda* brought together 17 participants from 14 organisations or businesses.

4.1.3. Designing the workshops

Workshop 1 is the main event on which we base this study due to the fact it was more thoroughly planned and had a longer duration. The core topic of this workshop was to map how different practitioners perceive SES issues from a corporate perspective using certain arguments. We wanted to analyse the different positions taken by academics and corporate representatives with regard to SES thinking and risk management (see the guiding questions in the *Supplementary Materials*, Table S1). This was done in order to inform the analytical process of disentangling aspects of the 'corporate-ecological disconnect'. The discussions during the workshop also facilitated the analysis of the opportunities and challenges of transdisciplinary research in the field of corporate sustainability.

In order to design the second workshop we adopted a similar strategy. Our goal was to analyse different positions taken by academics and different corporate representatives in regards business models. In this case, due to the third co-author's expertise in organisational studies, the first and the third co-author began to plan a follow-up workshop. Following Lang et al. (2012), we contacted a sustainability expert from a company, who had been an active and competent member. This sub-team planned the second workshop.

We wanted to ensure that the process was not a one-way street in terms of communication but rather a real dialogue (hence, not a situation where academics 'teach' corporate representatives what sustainable development is and how it should be implemented in corporate activities), in line with the aim of creating a process of 'mutual learning and exchange of knowledge' (Lang et al., 2012, p. 26; von Wehrden et al., 2019, p. 882). The rationale behind this particular aim is that academics are often detached from the corporate world and therefore are not fully aware of the difficulties and implications of applying academic models of corporate management in practice (e.g. Peters and Wals, 2013; Tucker and Lowe, 2014).

Careful considerations of the above mentioned aspects were integrated into **Phase A** and evolved during **Phase B**.

4.2. Phase B: Co-creation of solution-oriented transferable knowledge

In this study, **Phase A** is partly formalised meaning that the phases did not fully match our transdisciplinary research process. Rather, **Phase A** evolved together with the establishment of solution-oriented transferable knowledge in **Phase B** that allowed for collaborative research.

For Workshop 1, we almost immediately began to plan for inclusive communication with corporate representatives. We sent out individual invitations to the workshop and made follow-up phone calls. Furthermore, we discussed how to best formulate the aim and scope of the workshop to foster 'mutual learning and exchange of knowledge' (Lang et al., 2012, p. 26; von Wehrden et al., 2019, p. 882). This focus facilitated a safe, relaxed, and natural atmosphere where everyone could speak his or her mind, and seems to have enabled trust amongst the participants. This can be seen from the transcripts from Workshop 1, specified in the autoethnographic accounts of the first co-author. However, it is not possible to measure whether we enabled a research process that went beyond both the 'primacy of science' and the 'primacy of practice'.

In Workshop 2, we discussed the drivers of, and barriers to organisational change. The findings showed that there are several major barriers to collaboration that arise from the outset. For example, in line with the risk set out in design principle (c) by Lang et al. (2012) (see section 2), many corporate representatives lack the time and flexibility to break away from their work responsibilities to give attention to a transdisciplinary project. Secondly, it is important to schedule time for establishing good communication structures, which itself leaves less time to develop the conceptual process. The first hours of the collaboration in a project need to be well planned and useful for all participants. It should be an open discussion about how the process will look from the start and academics must be better at describing how they work. Thirdly, according to the field notes from Workshop 2, participants expressed concerns that transdisciplinary projects that they have been part of previously are sometimes initiated too quickly, which results in practitioners not feeling integrated into the team, or lacking an understanding of key concepts or processes. In order to avoid such situations, participants suggested starting with a more personal discussion on how to establish a common ground for planning the transdisciplinary process. For example, discussion of overarching goals and targets, structures of meetings, and expectations of participants is necessary.

Throughout the process, interpersonal bonds played a key role in co-creating knowledge. In order to establish those interpersonal bonds, it is vital to pay attention to the factors outlined above. We therefore carefully planned the workshops and aimed for them to be useful for all participants. The corporate participants in the SMART Business forum established an important connection between the transdisciplinary process and the corporations that they represent. When the participation of a corporate representative declined, the collaboration with the company also stalled or stopped altogether. This became evident when studying the list of participants for the workshops, and compared to additional events and communications that we have had in the SMART project, including the Business Forum.

4.2.1. SES thinking as a bridging concept in corporate sustainability and capabilities and interest in participation

The main findings from **Phase B** are summarised in Table 3 and show that there are some key areas that should be further investigated. Our findings suggest that SES thinking can be used as a bridging concept in transdisciplinary research collaboration for

Table 3

Main findings: SES thinking can be used as a bridging concept and it is key to consider participants' capabilities and interest in collaboration.

SES thinking as bridging concept	Capabilities for and interest in participation
<p>Proposition SES thinking can be used as a bridging concept with the support of the concept of risk.</p>	<p>To overcome the tension between approaches of 'primacy of science' and 'primacy of practice' we focused on barriers and possibilities of participation (in line with Stokols et al. (2010) and Lang et al. (2012)). → We designed a process of <i>mutual learning and exchange of knowledge</i> (see Lang et al., 2012, p. 26; von Wehrden et al., 2019, p. 882, p. 882)</p>
<p>Findings The concept of risk is a useful for conveying SES thinking by:</p> <ul style="list-style-type: none"> • Integrating sustainability into top management procedures • Asking critical questions that imply risk • Turning risks into opportunities • Expanding usual corporate conceptualisation of financial risk as it does not encapsulate the financial aspects of unsustainability 	<p>Careful considerations around group dynamics are important:</p> <ul style="list-style-type: none"> • Our approach resulted in a safe, relaxed and natural atmosphere • According to our experience, this seems to have enabled trust amongst the participants

corporate sustainability. In line with the literature, we find that it is important to use language that is relevant to both communities in the transdisciplinary research process. For example, in the first workshop (a) the notion of *risk* and *risk management* acted as useful metaphors for SES thinking. Good collaboration requires careful consideration of (b) capabilities and interest in participation. We develop these findings below through analysing the testimonies of the interviewees.

Corporate practitioners and researchers have often different conceptual understanding of sustainable development, how to tackle the issues arising from this mismatch, or what this means for practice. The scientific call for increased use of SES thinking seems to be almost absent in corporate language concerning corporate sustainability. Corporate language usually includes simpler concepts, which usually means that many aspects of sustainability are lost as this quote from an energy and maritime company illustrates:

I find it very difficult to communicate the complexity of these [sustainability] issues with standard social science language, when I talk to risk management people (...). Also, it is very difficult to put forward the idea that forecasting certain things in relation to sustainability is very difficult – you need to have a systems perspective, a companywide perspective and often make a best guess. So these complex adaptive systems, social-ecological issues and their embeddedness in economic activity is not really the language we speak in companies and we need to translate it to standard language of risk and risk management – however, I'm not sure that a mere translation enables an appropriate integration of these issues in companywide processes. (19)

4.2.1.1. *Systems thinking in corporate sustainability practices.* Some corporations do work with the concept of SES thinking. For example, Interviewee 5, from a clothing company, expressed their view on how to examine the concept in the corporate setting:

First and foremost, it is a mind-set, it is a world view. (...) The world is a very complex system but a lot of people act as if it is not. So actually, it is just realising, or viewing the world as it is and not simplifying too much. And being aware that everything works in big systems. You have to acknowledge that as a company and then try to act accordingly and that could be hard. When we do our planet boundary assessment, we try to look at every aspect of the planetary boundaries, for instance, and not only look at the carbon dioxide footprint, or water use, because usually it is a big trade-off between these two. And it is very convenient to choose one [aspect] that may be the one most heard of in society that you think you are going to gain the most of talking about, or the one that is easiest for you to make a big change. (15)

Likewise, another manager described how they integrate SES

thinking by 'translating' the concept into corporate language:

We are striving for profitable growth of solutions, that help us thrive within planetary boundaries (...) So, we need profitable growth, which speaks directly the corporate language and the business mind-set that is really the core of a business. (...) To combine that with the solutions that help us thrive within the planetary boundaries, is a way for us to really emphasise that it is not any business. It's not any growth. It is only the growth of the things that are good for us that is desirable. (13)

Another interviewee from a bank expresses the usefulness of environment, social, and governance (ESG) considerations in relation to risk management as these concepts can be used to foster business practice in line with SES thinking:

... the question [of SES thinking] as such is not challenging, but to put it into practice [is]. If you break it down into environmental, social and governance risk, sort of ESG risk. (...) So it [scenario analysis] is very much still based on traditional financial risk, but now we of course see that climate risks are increasing but these are somewhat weather-related and the weather is hard to predict, so it is very difficult to integrate this into our models. (...) the physical risk, which is the immediate risk; risks of fires, flooding, or things like that. Transitional risk is the risk for companies that are doing business in a way today that might not be allowed to be conducted in 10, 50 years from now. (...) And you have the social and governance risks, for us they are very much tied to reputational risks for ourselves. Reputational risk is described as a consequential risk arising from other risks so to speak. (14)

However, several interviewees also reported that they do not work with SES thinking:

I cannot say that I am using that [SES thinking] in my language. We are a sub-supplier, so typically our customer comes to us with often close to finished constructed products, and asks us for a quote to produce it. The main reason why we have implemented sustainability in our strategy is because it is important for us to have the technology and knowledge to produce recycled materials, because we believe that our customers will demand it more and more in the future. (11)

4.2.1.2. *Traditional risk management strategies.* The corporate understanding of risk seems to be different from the scientific understanding, which is described by Interviewee 9:

Sustainability is often not part of standard risk management processes. So we have already heard from many scholars and practitioners the idea that having one Chief Sustainability Officer in

charge of sustainability issues does not mean that it [sustainability] is integrated in companywide processes. Part of the alignment and integration would be to understand these issues as liabilities, as costs, as financial, material and business continuity risks - acting upon these and integrating them accordingly. (19)

Another interviewee elaborated that many corporations are mainly focusing on due diligence and specific liabilities that they have identified as major components of risk. As such, they completely disregard financial aspects of unsustainability:

Because they [the companies] understand risk, they don't necessarily understand the risk and opportunities emerging from global sustainability challenges. They do understand the risk of not complying with law given that they can lose their "license to operate" or get a financial fine. This means that if the law should be used as a mean to push corporates into sustainable actions, they [the companies] must feel a financial risk if not complying with the law. (18)

The risk of unsustainability is not included in traditional risk management process and the way corporate representatives think about risk. Moreover, the usefulness of this metaphor is contested:

Currently, in our formal risk management process that we have developed through the ISO 9001 and 14001, I would not say that it is [SES thinking] a part of our formal, written risk management. But (...) when we know the product and the client well enough to know what will happen with the product after end of life, we will try to see what opportunities can come from that product when it has done its purpose. But it's not part of our written quality or risk management plans. It's not. But maybe it should be. (11)

I think risk is a very expected word, because you spent so much time moving away from risk management. But it should not be about risk, it should be something integrated with the business (...) risk has a negative connotation. So, we have actually worked so many years to walk away from that word, but I think management is great. But I would be very careful, because risk management means that you go directly into risks for business. You go directly to risk for losing money. (12)

4.2.1.3. The continuum between risk and opportunity. We further identified some possible process-related aspects of working with risk in this context. First, we identified the importance of establishing processes from top management level to operational level. Interviewee 6 provided a concrete procedural example of how sustainability risks are transferred into business risks:

What we do as a discipline, is that we have increased competence of employees working both in the line and dedicated sustainability resources on sustainability in risk management. So for example with human rights, we break it down to all kinds of human rights issues, they should always evaluate these risks and the corresponding sources - risk factors - related to the country or project activities they are working on. If it is a material risk or risk factor, they discuss and nominate the risks for discussion in a risk workshop, and then it is ranked and integrated into the risks register for that country or project. If a sustainability risk is considered significant, it can be transferred to the "business area" risk level. That means that it gets more attention, and subsequently recurses are allocated to manage this - a sustainability risk factor could actually become both a severe cost and reputation issue. If it is on the business area level, it could potentially also be escalated further to the CEO, and even to the board level. (16)

Second, corporate representatives acknowledged the importance of analysing how risks could be transformed into opportunities. Interviewee 7 explained:

You need to talk about the risk issue, but you also need to talk about the possibilities. Because, more and more the management teams that we work with, they see the possibilities. And they are curious about the possibilities - you can use them boldly because then they get interested, because it actually touched their mind. To be honest, it is a change. (17)

4.3. Phase C: integration and application of created knowledge?

As part of the SMART project, we have been seeking to initiate pilot projects, an initiative aimed at implementing the SMART SGM and SAT (see Table 2, Sjäfjell and Muñoz-Torres, 2019; SMART, 2019c) in corporate practice. The SAT developed by Muñoz-Torres et al. (2018) is an attempt to improve sustainability assessment practices. Their tool includes a methodological framework that assesses the extent to which corporations contribute to improving social aspects of sustainability (Raworth, 2017) while staying within planetary boundaries (Rockström et al., 2009; Steffen et al., 2015). While it is too soon to report the findings from **Phase C**, initial discussions in the negotiating phase show a corporate interest in using the SMART SGM and SAT.

We have identified a couple of challenges in the early stages of **Phase C**. These include: (a) differing conceptions of sustainable development, which hinder the development of a joint understanding of how to design the pilot collaboration. Another major problem is that (b) the metrics and targets deployed to identify and measure material issues, (where the greatest impact can be achieved) are often not common to corporations and academics. From the corporate perspective, it is important to use standardised tools and processes for materiality assessments. From the academic side, there is a need to include more complexity to the analysis (see the work on complexity and sustainability by e.g. Liu et al. (2007) and Wells (2012)). This can often result in the use of metrics that are too numerous and too complicated for the average corporation. Additional problems that create barriers to establishing pilot projects relate to how to tackle the issue of (c) access to data, (d) funding, and (e) time. While funding usually is not a major problem for large corporations, data is. On the contrary, funding is scarce in smaller firms, while data protection is not as extensive, meaning there are better opportunities to use the firm's data. These five challenges outline the main barrier to the initiation of **Phase C**.

5. Discussion

The different **Phases A-C** in the ideal-typical transdisciplinary research process developed by Lang et al. (2012) are all demanding. However, within the scope of this study the major challenge was initiating **Phase C**, integration of the co-created knowledge. The main barriers that we have identified are (a) conceptualisation of sustainable development, (b) the metrics and targets for assessment (c) access to data, (d) funding and (e) time.

We suggest that it is useful to apply the conceptualisations of integrating different knowledge systems elaborated by Tengö et al. (2014) when applying the methodological framework by Lang et al. (2012). This is deemed useful for unpacking different actor groups' understanding of concepts. For example, in the discussion on the concept of SES thinking, it became evident that we need to consider parallel approaches to using sustainability concepts in order to move towards, in our case, co-production of knowledge. The

importance of acknowledging the complementarity of each actor group's approach and the different contexts within which each actor group operates becomes key. This is in line with Tengö et al. (2014, p. 584).

In our study, the process of co-creating knowledge for corporate sustainability through corporate-scientific collaboration requires enhancement of corporate representatives' capabilities and interest in participation. Thus, this is key in order for them to be able to break away from daily routines and engage in the activities of the project.

5.1. Transdisciplinary research frameworks

The process of co-creating knowledge was slightly different compared to the framework developed by Lang et al. (2012). This is not surprising as their design was by purpose generic. However it needs to be addressed. First, our process had more emergent aspects. For example, we did not initially foresee that the collaboration established in the first workshop would result in a second workshop (see section 4.1.2.). Therefore, our study shows that while it is possible to design some elements of the co-creation process, the capacity of the research team to adapt and respond to emergent and unforeseen circumstances is also important.

Second, the collaboration dynamics that we observed were less linear. For example, **Phases A** and **B** were overlapping rather than processual phases. While Lang et al. (2012) propose that the problem-framing occurs in **Phase A**, in our study the problem-framing phase was still changing and evolving as the project progressed. The dynamic nature of the problem-framing in our study could be due to its position in a larger research project with a broad research focus. This enabled us to have two different themes of the workshops. The second workshop had a focus on the process organisational change while the topic of SES thinking in Workshop 1 was more conceptually oriented. The context of being part of a larger project allowed for the two themes, as the project has many members with diverse expertise. These focuses are however related because participants in the second workshop discussed the means to enable large-scale enhancement of sustainability in organisational change and build on the findings from the first workshop. As the themes of the workshops were slightly different, different people needed to be involved due to the need for diverse knowledge and varying levels of interest.

5.2. Communication with corporate representatives

In our experience, interpersonal bonds have a key and salient role (Lang et al., 2012) owing to the fact that collaboration is often dependent on a small handful of people in the corporation. If that relationship somehow fails, the whole corporation's engagement may also fail as a result. In an academic-corporate collaboration, 'salience' is also dependent on how well the 'mutual learning and exchange of knowledge' process develops (see Lang et al., 2012, p. 26; von Wehrden et al., 2019, p. 882). As such, if the process acknowledging the complementarity of different knowledge (*sensu* Tengö et al., 2014) is not articulated clearly, participants may feel overrun. This means that different opinions with regard to 'whose knowledge' is most valid is connected to self-perception, and actors may have very different perception of what competence is necessary to solve a problem and of 'how important' their own work is (see findings from Workshop 2 in section 4.2.).

This discussion is related to in *what way* and *how* the process of exchanging knowledge has developed. Transdisciplinary projects and comprehensive research agendas with the aim of solving of global sustainability challenges often require encounters between unfamiliar actors, scientific paradigms and professional cultures

(Ellingsen, in press). Transdisciplinary research can be challenging because of lack of common knowledge, social unpredictability and low levels of trust (von Wehrden et al., 2019). Consequently, transdisciplinary research could be enhanced by establishing common platforms for interaction, development of mutual understanding and shared expectations. Co-creation of knowledge can be regarded as a joint process of knowledge integration and social integration, meaning that the scientific work is mixed with trust development (Ellingsen, in press). The notion of trust is considered key (see findings from workshop 1 in section 4.2.) in order to successfully develop a joint knowledge integration process (see also von Wehrden et al., 2019).

The outcome from the collaboration in the SMART Business Forum and the affiliated workshops, have to some extent resulted in *integration of knowledge*. For example, risk as a metaphor clearly enabled an integrative understanding amongst participants when discussing how SES thinking could be better incorporated into corporate sustainability practices (see section 4.2.1.1. and 4.2.1.2.). Aspects of this transdisciplinary effort could furthermore be argued to be (c) *co-production of knowledge* (in line with the aim of **Phase B**) as we initiated small sub-teams that planned workshops and co-produced different propositions on how to use SES thinking as a bridging concept in corporate sustainability practices (see section 4.2.1.), and agreed on some major barriers to organisational change.

5.3. SES thinking as a bridging concept in transdisciplinary research: using traditional risk management strategies

In our study, a significant component of the 'corporate-ecological disconnect' is a lack of mutual understanding between academics and practitioners regarding how to best improve and intensify corporate sustainability practices. The importance of integrating a holistic notion of sustainable development that aims to achieve human wellbeing (Raworth, 2017) within the planetary boundaries (Rockström et al., 2009; Steffen et al., 2015) is clear and pressing. SES thinking underlines the science behind the planetary boundaries framework (Rockström et al., 2009), and has shown to be crucial for understanding sustainability problems (e.g. Berkes et al., 1998; Berkes et al., 2003; Carpenter et al., 2012). While academic understanding of sustainable development has emerged and developed in recent years (Sjåfjell and Bruner, 2019), our findings indicate that this perspective has not been sufficiently transferred to the corporate sector.

In section 4.2.1, we show that SES thinking can be used as a bridging concept in transdisciplinary collaboration in corporate sustainability, if translated into practical language. The concept may need to be translated or accompanied by concepts that are more tangible for practitioners. For example, in our workshop the concept of risk management acted as a useful metaphor to convey SES concepts to practitioners. Risk management as an approach to solving sustainability challenges created significant debate. However, the concept of risk is often used differently in the academic and corporate sectors (see e.g. Sjåfjell, 2018; Keys et al., 2019). For practitioners, social and environmental risks are often converted to the language of finance and conveyed as financial risks that may jeopardise the firm's bottom line. Furthermore, participants expressed that internally risk management is also related to the process of integrating sustainability aspects into corporate governance procedures, hence, transforming the identified sustainability risks into opportunities. This means transferring those risks from the operational level up to top management level (see section 4.2.1.3.). However, from an academic sustainability perspective, organisations both create and are recipients of systemic risks that manifest across spatial and temporal scales (Whiteman and Williams, 2018). Therefore, risk management should be

conceptualised at a systemic level and seek to ensure human wellbeing (see Raworth, 2017) while staying within planetary boundaries (Rockström et al., 2009; Steffen et al., 2015). This is a very different conceptualisation of risk than is used in most corporations.

6. Conclusions

Our findings show that under the right conditions and through co-created activities, it is possible to use SES thinking as a bridging concept in transdisciplinary research collaboration for corporate sustainability. We conclude that in order to co-create corporate-academic knowledge, it is necessary for project leaders to enhance corporate representatives' capabilities and interest in participating in transdisciplinary collaboration. One identified barrier here is a lack of mutual understanding of concepts between academics and corporate practitioners. The scientific call for increased use of SES thinking is not part of the common corporate lexicon relating to corporate sustainability. Our findings show, however, that SES thinking could be translated through processes of risk management. Consequently, we suggest that risk management can be used as a metaphor or process to facilitate the integration of SES thinking into corporate sustainability practices.

Author contribution section

Hanna Ahlström: Conceptualisation, Data curation, Methodology, Investigation, Writing - original draft. Amanda Williams: Conceptualisation, Methodology, Resources, Validation, Writing - review & editing. Sigurd S Vildåsen: Conceptualisation, Methodology, Resources, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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