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Sustainable & Circular Business Model Innovation: Tools, Techniques & Strategies for Firms

Thesis for the degree *Philosophiae Doctor* (PhD) at the
Western Norway University of Applied Sciences

Disputation: 27.05.2024

Year: 2024
Title: Sustainable and Circular Business Model Innovation:
Tools, Techniques and Strategies for Firms
Author: Matthew Coffay
Print: Molvik Grafisk / Western Norway University of Applied Sciences

ISBN 978-82-8461-096-2

Scientific environment

The doctoral research was carried out as part of the PhD program in Responsible Innovation and Regional Development at Western Norway University of Applied Sciences in Bergen, Norway.

Acknowledgements

This dissertation represents nearly four years of work. I started my research right at the beginning of the first COVID lockdown in Norway, back when we thought things would go back to normal after a few weeks. Roughly half of the dissertation period, then, was marked by long periods of working remotely, meeting my advisors, co-authors, and fellow PhD candidates and researchers entirely online.

It was a challenging time, to say the least. I wouldn't have made it through were it not for the support of some very special people.

Thank you to my supervisors, Lars Coenen and Ragnar Tveterås. Your support, guidance, and feedback throughout the PhD process were invaluable, and I am proud to call you friends and colleagues.

A special thank you to Nancy Bocken, my co-author on several of the papers during the PhD period. Though you were not an official co-supervisor, you treated me as though you were. I was routinely humbled by how generous you were with your time, expertise, and encouragement. For this, I am grateful.

Thank you also to Marcel Bogers and Robert Strand. It was a pleasure connecting and working with both of you, and I feel fortunate to have spent some time at UC Berkeley Haas during my research period.

A warm thank you to those who agreed to interviews and participated in workshops.

Thanks to all my fellow PhD candidates at HVL who shared mid-day coffee breaks, commiserated over the occasional drudgery of research and sometimes 'the world is ending' stress exercised upon us by Reviewer #2. Thanks especially to Frida Olsen Engedahl who stood by me through some very difficult times toward the end of this process, and to Nick Stemkowski, who did the same from afar.

And thanks to Albie, who was there when I got my acceptance letter, when I struggled during COVID, and when I submitted the dissertation. I don't know what I would have done without you, buddy. Here's to 10 more years. <3

Preface

Taking sustainability seriously is no longer an option for large companies. New strict regulatory regimes, growing public demand, and pressure from within are all forcing companies to think about new, sustainable business models. Opportunity in this space is also substantial, with both major potential for value creation alongside the competitive advantage conferred by more sustainable (and therefore more resilient) forms of operating. Despite all of this, companies still struggle to design and implement more sustainable business models, and the global circularity gap is widening rather than closing. The research conducted here is meant to contribute to closing both these gaps, and I am confident that the tools and insights I have developed do in fact make such a contribution, however small it might be.

On a more personal note, in spite of how far we still have to go in order to reverse current environmental trends, I find myself hugely optimistic at the conclusion of my dissertation. This optimism doesn't come from the insights I've gained or the limited contribution I've made. Instead, it comes from all of the inspiring people I've encountered over the past three years while conducting this research. It comes from the students and doctoral candidates who are engrossed in their work. It comes from my co-authors who are working tirelessly to advance important fields of research that will move all of us forward. And it comes especially from the corporate innovators I've met who are fully committed to transforming their companies into sustainable and circular organizations, regardless of the obstacles in front of them.

It's easy to succumb to pessimism, and the sheer scope and scale of the environmental challenges in front of us can be daunting. But whenever I feel overwhelmed, I think about all these inspiring people. While I'm proud of the work I've done here, it's the combined effort of all of us — many millions of us — that will make a difference.

Here's to those millions, and to you, reader.

Now, let's get to work.

Bergen, August 8, 2023

Abstract

Firms are increasingly aware of the need to transition to more sustainable and circular ways of doing business. This can arguably be best achieved through innovation not at the level of technology, product, or service, but rather at the level of an organization's business model(s). Sustainable business model innovation (SBMI) aims to create positive and/or reduce negative environmental and social impacts through changes to a firm's value creation, capture, and delivery mechanisms, while circular business model innovation seeks to create, capture, and deliver value by replacing linear resource use with the narrowing, slowing, closing, and regenerating of resource loops. Despite their awareness of the potential gains in revenue, resilience, and competitiveness afforded by these kinds of business models, the vast majority of large organizations and multinational corporations still struggle to successfully design and implement new, sustainable and circular business models in practice. This 'design-implementation gap' stands in the way of the transition to more sustainable forms of production and consumption.

This dissertation aims to bridge this gap through the development of practical tools and insights for practitioners, while also making a theoretical contribution to the literature in this area. Grounded in a pragmatist epistemology, the research conducted here first synthesizes responsible innovation and effectuation in developing the concept of a Responsible Innovation Lab as well as two accompanying tools, the Responsible Innovation Tool and Responsible Impact Tool. The dissertation further leverages a design science research approach in developing and testing two tools for managers, the Circular Experimentation Workbench and Sustainable By Design. The latter tool brings together three important concepts — organizational design, dynamic capabilities, and SBMI — in helping practitioners overcome the design-implementation gap. The connections between these concepts are further investigated as part of a case study with elements of action research, resulting in actionable insights for managers while advancing theory around how these concepts relate.

The tools developed here are themselves 'key findings' and results of the research. Other key findings include the value of collaboration, experimentation, and

embracing effectuation in overcoming the design-implementation gap. Research findings underscore the importance of organizational culture in determining a firm's ability to develop the dynamic capabilities needed for SBMI, and the inherent challenges firms will face in attempting cultural transformation for sustainability. More broadly, the research finds that firms must address key organizational design issues — including barriers and drivers at the level of culture, strategy, and operations — in order to overcome the design-implementation gap.

These challenges can be addressed in part by leveraging the tools developed here. Future research may further bridge the design-implementation gap by continuing to explore the connections between responsible innovation and effectuation in the form of a Responsible Innovation Lab; investigating the outcomes of circular business model experimentation, in particular through the use of tools like the Circular Experimentation Workbench; applying a tool like Sustainable By Design to study long-term firm outcomes in addressing cultural, strategic, and operational barriers and drivers to SBMI; and further studying the connections between organizational design, dynamic capabilities, and SBMI in other industry and case contexts.

Sammendrag

Bedrifter blir i økende grad klar over behovet for å omstille seg til en mer bærekraftig og sirkulær drift. Dette kan best oppnås gjennom innovasjon, ikke på teknologi-, produkt- eller tjenestenivå, men snarere gjennom bedriftens forretningsmodell(er). Bærekraftig forretningsmodellinnovasjon (SBMI) har som mål å skape positive og/eller redusere negative miljømessige og sosiale påvirkninger gjennom endringer i en bedrifts verdiskapings-, verdifangst- og verdileveringsmekanismer. Sirkulær forretningsmodellinnovasjon søker derimot å skape, fange og levere verdi ved å erstatte lineær ressursbruk ved å snevre inn, redusere, lukke eller regenerere ressursløp. Til tross for at bedrifter er bevisst på potensielle gevinster i inntekt, motstandskraft og konkurranseevne som denne typen forretningsmodeller kan gi, har flertallet av store og internasjonale selskaper store utfordringer med å designe og implementere nye, bærekraftige og sirkulære forretningsmodeller i praksis. Dette "design-implementeringsgapet" står i veien for overgangen til mer bærekraftige former for produksjon og forbruk.

Denne avhandlingen tar sikte på å bygge bro over dette gapet gjennom utvikling av praktiske verktøy og innsikt for praktikere, samtidig som den gir et teoretisk bidrag til litteraturen på feltet. Forskningen har blitt utført med utgangspunkt i en pragmatisk epistemologi, og kobler først ansvarlig innovasjon og 'effectuation' i utvikling av konseptet om en ansvarlig innovasjonslab, samt to tilhørende verktøy, «Responsible Innovation Tool» og «Responsible Impact Tool». Gjennom en serie av workshops med fagfolk og bedrifter fra ulike næringer har avhandlingen benyttet en designvitenskapelig forskningstilnærming i utviklingen og testingen av to verktøy for praktikere på bedriftsnivå: «Circular Experimentation Workbench» og «Sustainable By Design». Sistnevnte samler tre viktige begreper, organisasjonsdesign, dynamiske kapabiliteter og SBMI, for å hjelpe praktikere med å overkomme design-implementeringsgapet. Koblingen mellom disse begrepene utforskes videre som del av en casestudie av den norske lakseindustrien med fokus på utviklingen av en ny verdikjede for offshore havbruk. Casestudien innebærer elementer av aksjonsforskning, og gir handlingskraftig innsikt for praktikere og videre teoretisk forståelse av hvordan organisasjonsdesign, dynamiske kapabiliteter og SBMI henger sammen.

Verktøyene utviklet her er i seg selv «nøkkelfunn» og forskningsresultater. Andre hovedfunn inkluderer verdien av å samarbeide, eksperimentere og omfavne 'effectuation' for å overkomme gapet mellom design og implementering. Forskingsresultatene understreker viktigheten av organisasjonskultur for å avgjøre en bedrifts evne til å utvikle de dynamiske kapabilitetene som trengs for SBMI, og de tilhørende utfordringene en bedrift vil møte i en kulturendring for bærekraft. Mer generelt viser forskningen at bedrifter må adressere viktige organisatoriske designproblemer, inkludert barrierer og drivere på kultur-, strategi- og driftsnivå, for å overkomme design-implementeringsgapet.

Disse utfordringene kan delvis løses ved å anvende verktøyene utviklet her. Fremtidig forskning kan ytterligere bygge bro over design-implementeringsgapet ved å 1) videre utforske koblingene mellom ansvarlig innovasjon og 'effectuation' i ansvarlige innovasjonslabber, 2) undersøke utfall fra eksperimentering med sirkulære forretningsmodeller, da spesielt ved bruk av verktøy som «The Circular Experimentation Workbench», 3) anvende verktøy som «Sustainable By Design» for å studere langsiktige utfall i bedrifters håndtering av kulturelle, strategiske og driftsbarrierer og drivere for SBMI, og 4) videre studere koblingen mellom organisasjonsdesign, dynamiske kapabiliteter og SBMI i andre næringer og kontekster.

Contents

List of publications

The dissertation consists of four papers. At the time of submission, two of these papers have been published (Papers I & II), while two are in review (Papers III & IV). The papers are arranged in the order below with the intention of building theoretical, conceptual, and empirical insights for the reader when read in this order. Paper I provides theoretical and conceptual grounding in effectuation theory and responsible innovation, while also developing two conceptual tools. Paper II further elaborates on effectuation theory and connects it with circular business model experimentation in the form of a workshop process tool. Paper III provides theoretical background and grounding in sustainable business model innovation (SBMI), organizational design, and dynamic capabilities, and further builds useful theory and practitioner insights at the intersection of these literatures via a case study based in Norway. Paper IV builds further on organizational design and SBMI, developing and testing a tool for organizational design with two multinational corporations (DSM and IKEA Retail / Ingka Group).

Paper I: Coffay, M., Coenen, L., Tveterås, R. 2022. Effectuated sustainability: Responsible Innovation Labs for impact forecasting and assessment. Journal of Cleaner Production, 376, 134324. https://doi.org/10.1016/j.jclepro.2022.134324

Authors' contributions: Conceptualization: Matthew Coffay, Lars Coenen, Ragnar Tveterås. Methodology: Matthew Coffay. Writing - original draft preparation: Matthew Coffay. Writing - review and editing: Matthew Coffay, Lars Coenen.

Paper II: Bocken, N., Coffay, M. 2022. The Circular Experimentation Workbench – a lean and effectual process. Circular Economy and Sustainability. https://doi.org/10.1007/s43615-022-00239-w

Authors' contributions: Conceptualization: Nancy Bocken, Matthew Coffay. Methodology: Nancy Bocken. Formal analysis and investigation: Nancy Bocken, Matthew Coffay. Writing - original draft preparation: Nancy Bocken, Matthew Coffay. Writing - review and editing: Nancy Bocken, Matthew Coffay

Paper III: Coffay, M., Tveterås, R., Bocken, N., Bogers, M. Sustainable business model innovation, dynamic capabilities and organizational design: Insights from Norwegian aquaculture. (Forthcoming). Business Strategy and the Environment.

Authors' contributions: Conceptualization: Matthew Coffay. Methodology: Matthew Coffay, Ragnar Tveterås. Formal analysis and investigation: Matthew Coffay, Ragnar Tveterås. Writing - original draft preparation: Matthew Coffay. Writing - review and editing: Matthew Coffay, Ragnar Tveterås, Nancy Bocken, Marcel Bogers. Funding acquisition: Ragnar Tveterås.

Paper IV: Coffay, M., Bocken, N. Sustainable By Design: An organizational design tool for sustainable business model innovation. Journal of Cleaner Production, 427, 139294. https://doi.org/10.1016/j.jclepro.2023.139294

Authors' contributions: Conceptualization: Matthew Coffay. Methodology: Matthew Coffay, Nancy Bocken. Data collection: Matthew Coffay. Data analysis: Matthew Coffay, Nancy Bocken. Writing - original draft preparation: Matthew Coffay, Nancy Bocken. Writing - review and editing: Matthew Coffay, Nancy Bocken.

Papers I, II and IV are published open access. Paper III has been accepted for publication and is forthcoming. It will also be available open access.

List of Figures, Tables and Abbreviations

Figures

Tables

Abbreviations

SBM: Sustainable business model

SBMI: Sustainable business model innovation

CBM: Circular business model

CBMI: Circular business model innovation

1. Introduction

In light of growing environmental externalities, increased exposure to risk, environmentally-driven supply chain disruptions, and mounting stakeholder demands, firms increasingly must incorporate sustainability considerations into their core culture, strategic goals, and day-to-day operations. Many have already set ambitious sustainability goals, with more than 5,000 global companies setting science-based emissions reduction targets and nearly 2,000 making net zero commitments (Science Based Targets, 2023). Despite this, large multinational corporations (MNCs) continue to struggle with actually designing and successfully implementing new and sustainable ways of doing business in the form of more sustainable business models (Geissdoerfer et al., 2018).

This dissertation examines the phenomenon of sustainable business model innovation (SBMI), a process in which firms reduce negative environmental and social impacts and/or create net positive impacts through innovating on their processes of value creation, capture, and delivery — that is, through their business models (Bocken et al., 2014; Osterwalder & Pigneur, 2010). It investigates how firms might reach their environmental sustainability goals in particular by innovating at the business model level, developing both theoretical insights to advance the research field as well as practical tools that empower firms to succeed with SBMI. Grounded in pragmatism, the dissertation takes an action- and design science-oriented approach to developing these tools and insights which are needed to address the so-called 'design-implementation gap' in SBMI: that is, the gap in firms' ability to successfully design and implement new, sustainable business models. Ultimately, the dissertation aims to both advance the state of the art in this research field while also making a substantial contribution to practice. It does so by ensuring that the tools developed in the dissertation are well-designed, easy to use, and effective, while also translating theoretical contributions into practical and actionable insights for firms.

This first chapter lays out the context of global sustainability challenges within which companies must engage in SBMI. It then describes the research gap which the dissertation addresses. Lastly, it provides an overview of the papers which comprise

the dissertation, showing how their contributions fit together into a coherent whole via an overarching framework.

1.1. Context: Global sustainability challenges

Global awareness of the risks and impact of our rapidly changing climate has never been higher. For all the effects experienced in recent years — droughts, flooding, wildfires, heat waves, crop losses — there is clear evidence that things will worsen substantially by 2040 if we fail to take rapid action for mitigation (IPCC, 2022a). At the same time, the latest report from the IPCC on existing mitigation efforts has concluded that adhering to current Nationally Determined Contributions (NDCs) would likely result in more than 1.5°C of warming, while existing policies actually overshoot even these insufficient NDCs (IPCC, 2022b). Worse still, the report finds that "without a strengthening of policies beyond those that are implemented by the end of 2020, GHG emissions are projected to rise beyond 2025, leading to a median global warming of 3.2 [2.2 to 3.5] °C by 2100" (IPCC, 2022b, p. 17).

But this is only climate change. And while there is no doubt that rapid mitigation efforts are needed to decarbonize as quickly as possible, it is just as important to simultaneously consider and address other sustainability concerns such as those related to biodiversity and resource extraction. Media attention around climate change has propelled discussions of mitigation, adaptation, and 'net zero' commitments from businesses and governments to the forefront of the sustainability discussion — but this has led to a kind of 'carbon tunnel vision' wherein sustainability discussions have become stuck in a paradigm of cutting carbon at all costs. The reality is that a net zero society could still be an incredibly unsustainable one. For example, it makes little difference if we've managed to reduce emissions to zero by leveraging highly extractive business models which achieve 'emissions reduction' primarily through carbon offsets.

Fortunately, there is growing awareness around the importance of a more nuanced and balanced approach to sustainability. The recent emergence of the Montreal-Kunming Biodiversity Framework has set ambitious goals on the biodiversity front, including conservation of 30% of terrestrial, ocean, and coastal

ecosystems by 2030, $700 billion USD per year in global investment to achieve the framework's goals, and new legal and policy measures which will require businesses to collect data and report on their biodiversity impact, with the aim of reducing negative impacts on biodiversity over time (UNEP, 2022).

But this dissertation is not primarily about global frameworks, regulatory schemes, and public policy. Rather, these are the backdrop for the focus of the dissertation: the intersection of business models and sustainability. Businesses are increasingly aware of the need to transition toward more sustainable and so-called 'circular' business models (Geissdoerfer et al., 2018; Geissdoerfer et al., 2020) as a means of contributing to a sustainable and circular economy — that is, one which replaces linear, extractive approaches to resource use with the slowing, closing, narrowing, and even regenerating of resource loops (Konietzko et al., 2020a; Konietzko et al., 2020b; Geissdoerfer et al., 2017; Bocken et al., 2016), and which can operate in alignment with the ambitious climate and biodiversity targets outlined above.

Where just a few years ago the ambition to adopt a sustainable or circular business model would have been unthinkable for many large organizations, this thinking has become increasingly mainstream. A report from McKinsey recently concluded that there exists a 500 billion EUR circular business opportunity for EU consumer goods companies alone (Gatzer et al., 2022), while the annual Circularity Gap report from Circle Economy (a leading EU circular economy thinktank) was co-developed with Deloitte for the first time in 2023 (Circle Economy, 2023). McKinsey's findings are echoed by the Ellen MacArthur foundation, which similarly found that a circular approach in the fast-moving consumer goods industry could result in net material savings of over $700 billion per year (Ellen MacArthur Foundation, 2013). Despite the value creation potential around circular business models, however, the global economy is at present only 7.2% circular (Circle Economy, 2023). This metric is derived from quantifying and subsequently tracing all energy, material, and waste flows through the global economy and determining what percentage of them (7.2%) are secondary materials which have been cycled back into the economy from 'waste' (as opposed to new materials which must be extracted, either from renewable stocks such as timber, or non-renewable stocks such as metal ores). This is a worsening

compared to recent years, as the same report found the global economy to be 9.1% circular in 2018 and 8.6% circular in 2020 (Circle Economy, 2023).

In summary, sustainability gaps are widening and targets are being missed. At the same time, there is an enormous amount of untapped value potential for companies that want to transition to sustainable and circular approaches to doing business (Ellen MacArthur Foundation, 2013). This transition is essential if we are to close these sustainability gaps.

This begs an obvious question: given rising external pressure combined with clear value creation opportunities, why are companies still so slow to transform the way they do business and adopt more circular and sustainable business models?

1.2. The need for sustainable business models and research gaps

Recent research has determined that firms are increasingly aware of the need to implement sustainability improvements, but struggle to meet their sustainability targets despite this awareness (Geissdoerfer et al., 2018). Radical innovation at the level of the business model — an innovation in how a firm creates, captures, and delivers value which departs significantly from prevailing business models in a given industry— is often needed to achieve sustainability goals (Rashid et al., 2013). Traditional business model innovation, typically understood as the act of devising new business models by altering existing models and/or designing and implementing new ones, can yield higher returns than product or process innovation alone (Chesbrough, 2007). Meanwhile, sustainable business model innovation (SBMI) — the act of designing and implementing new, sustainable business models (SBMs), i.e. those which "create significant positive [impact] and/or significantly reduced negative impacts for the environment and society, through changes in the way the organization and its value-network create, deliver value and capture value…or change their value propositions" (Bocken et al., 2014, p. 44) — offers firms a number of tangible firm- and sustainability-focused benefits, as outlined in Geissdoerfer et al. (2018) and Bocken & Geradts (2020). Choi & Wang (2009) found that greater engagement in developing and maintaining relationships with stakeholders other than shareholders — that is, those "whose primary benefit derived from the company

is not from…shareholder returns" (Coombs & Gilley, 2005, p. 827), including "employees, customers, suppliers, and the community at large" — could improve overall resilience and better mitigate long-term risk (Choi & Wang, 2009, p. 896). Buliga et al. (2016) demonstrated that business model innovation itself forms a type of "resilient response to environmental turbulence" fostered by organizational ambidexterity, and that business model innovation can help organizations survive and thrive in challenging circumstances (p. 661). Nidumolu et al. (2009) reviewed sustainability initiatives in 30 large companies and found environmental sustainability initiatives presented a "mother lode of organizational and technological innovations" which could "yield both bottom-line and top-line returns" (p. 57). They further noted the potential of sustainable business models to capture new revenue streams and provide entirely new services to customers, thus diversifying their offerings and opening up new forms of value creation (Nidumolu et al., 2009, p. 63). These findings are echoed by Tukker & Tischner (2006), who note the potential of service-based value propositions and business models for enhancing both competitiveness and sustainability. Bocken et al. (2014) show how so-called 'frugal business models' — a type of sustainable business model archetype which focuses on reducing complex business models to a "base functionality" which can be delivered at a lower cost to markets otherwise unable to afford them (p. 52) — can effectively cut the cost of production by paring down complex products into their core feature set and providing them to low income consumers, including those in developing countries, resulting in both social benefits (access to goods for those who might otherwise be excluded) and potential environmental benefits (reduced material throughput). Schaltegger et al. (2012) also note the potential of sustainable business models to reduce costs, both through energy savings and reduced material flows as well as the reduction of environmental and social risks, while simultaneously helping companies to anticipate future regulatory and stakeholder requirements and expectations (Jasch, 2008; Schaltegger & Wagner, 2006; Christmann, 2000; Epstein & Roy, 1996). Homburg et al. (2013) show how engaging in corporate social responsibility-driven business activities in business-to-business markets couple help improve trust and overall business reputation as a company that is "reliable and honest" (Homburg et al., 2013, p. 59; McWilliams & Siegal, 2001, p. 120), while Greening & Turban (2000) found that job applicants were more likely to pursue

positions at socially responsible firms over those with poor reputations for social performance. This finding that firms which prioritize sustainable ways of doing business can attract and retain top talent is echoed by Schaltegger et al. (2012), Ehnert (2009), and Revell et al. (2010).

Further, broadly speaking, it is substantial innovation at the business model level — developing entirely new business models, or transforming the business model into a new one with significant changes to value creation, capture, and delivery — which can allow companies to address long-term sustainability challenges that cannot be solved through simple, limited, or incremental changes to the existing business. Unlike incremental technological improvements, SBMI allows companies to "align incentives and revenue mechanisms to leverage sustainable solutions" (Geissdoerfer et al., 2018, p. 402; Rashid et al., 2013). Indeed, ambitious sustainability goals simply call for business model-level innovation if they are to be achieved (Bocken & Geradts, 2020; Geissdoerfer et al., 2018; Foss & Saebi, 2017; Laasch, 2019; Stubbs & Cocklin, 2008). It is the business model itself which can allow for the ongoing creation of the business case for sustainability: one which involves the "management of voluntary social and environmental activities in addressing the business case drivers in a systematic manner" (Schaltegger et al., 2012). Increasingly, even traditionally mainstream management scholars have begun to identify the competitive advantage afforded to firms which create so-called 'shared value', that is, value which is created for society by solving various environmental and/or social challenges in addition to generating revenue (Porter & Cramer, 2011). The importance of addressing sustainability considerations at a fundamental business model level continues to grow in light of increased external ESG risk and new regulatory regimes. The Corporate Sustainability Reporting Directive's (CSRD's) double materiality requirement, for example, will require that upwards of 50,000 businesses in the EU report not only on material financial impacts, but also those environmental impacts which are material to the undertaking, including those which would fall under scope 3 (supplier-related) emissions (EFRAG, 2022; European Commission, n.d.). This reporting must in turn be presented in business model terms, with companies soon being "required to disclose information about their business strategy and the resilience of the business model and strategy in relation to risks related to

sustainability matters" and further "disclose any plans they may have to ensure that their business model and strategy are compatible with the transition to a sustainable economy and with the objectives of limiting global warming to 1.5 °C in line with the Paris Agreement and achieving climate neutrality by 2050" (European Parliament, 2022). Given all of the above, it is now argued that non-sustainable business models will gradually become obsolete, with sustainable business models replacing them due to their superior competitive advantage (Geissdoerfer et al., 2018; Porter & Cramer, 2011; Nidumolu et al., 2009; Grant, 2010).

However, despite the presence of these benefits in combination with the value creation opportunities and external pressures described in the introduction, there remains a design-implementation gap: firms often struggle to successfully design and implement new SBMs (Geissdoerfer et al., 2018; Baldassarre et al., 2020). One clear reason for this is a lack of adequate tools. While many tools exist for traditional business model innovation (e.g. the Business Model Canvas (Osterwalder & Pigneur, 2010)), there are few good tools for SBMI or circular business model innovation (CBMI). Those that exist often suffer from design issues due to the lack of implementation of a rigorous stepwise design process, and/or were designed for specific contexts, thus lacking broader applicability (Bocken et al., 2019b). Additionally, while there are a number of tools available for sustainable or circular business model ideation — for example, variations of the Business Model Canvas which expand upon the idea of the value proposition to incorporate environmental and social considerations alongside economic value creation, e.g. the triple-layer business model canvas (Joyce & Paquin, 2016) or the flourishing business model canvas (Upward & Jones, 2016) — simply developing good ideas for new value propositions or business models — that is, designing new SBMs and circular business models (CBMs) — is inadequate for succeeding with the implementation of these same SBMs (Baldassarre et al., 2020; Bocken et al., 2019a; Bocken et al., 2019b). To succeed with implementation and overcome the design-implementation gap, firms also need tools which can help with experimentation, testing, and de-risking of SBM and CBM ideas — but such tools are still limited (Baldassarre et al., 2020; Breuer et al., 2018; Bocken et al., 2019b).

Further, while popular representations of business models such as the Business Model Canvas might suggest that business models are sets of neatly delimited components which can be altered or 'remixed' with relative ease in order to achieve innovation outcomes (see Section 2.1 for a discussion of the business model concept), the reality of succeeding at business model innovation is considerably messier and more complex. Internal logics, organizational culture, and stakeholder agency must align in order to implement new and innovative business models. Indeed, at the organizational level, firms sometimes suffer from cultural, strategic, and operational barriers within the organization which prevent them from successfully developing and adopting more sustainable business models. These barriers include things such as a culture which prioritizes shareholder over stakeholder value, or a strategic focus on exploitation of existing business model(s) in lieu of exploration of new, sustainable business models (Bocken & Geradts, 2020). In particular, organizational culture — those organizational norms which guide individual behavior — has been shown to influence both innovation and sustainability outcomes (Teece, 1996; O'Reilly, 1989; Tellis et al., 2009; Bock et al., 2011; Linnenluecke & Griffiths, 2010; Teece, 2018). Recent research further highlights the interrelatedness of business model innovation (BMI), dynamic capabilities, and organizational design, including the relevance of company culture for both organizational design and dynamic capabilities, but calls for empirical work to better illuminate how these relationships work in practice (Teece, 2018; Teece, 2014; Augier & Teece, 2009). These connections are equally relevant in sustainability contexts, where barriers and drivers at the organizational level have been shown to either facilitate or hinder the development of dynamic capabilities for sustainable business model innovation (SBMI). However, there is still a need for empirical research in specific industry contexts to better understand the relative importance and roles of these organizational factors. While Bocken & Geradts (2020) examined how these organizational factors present in some of the world's largest multinational corporations (MNCs) — Johnson & Johnson, Unilever, and others — the research presented here examines these barriers and drivers both in other large multinationals (IKEA Retail and DSM, Paper IV) as well as in somewhat smaller companies (revenue in the billions of dollars, as opposed to tens of billions, and with fewer global employees) with international footprints (Salmar, Grieg Seafood, Skretting, Paper III). Addressing fundamental issues at the level of

organizational design could aid firms in developing the dynamic capabilities needed to succeed with SBMI. As in the case of experimentation, testing, and de-risking of SBM and CBM ideas, this is another area where a tool could assist practitioners, enabling them to overcome the design-implementation gap.

Further, while it is increasingly evident that multi-stakeholder collaboration is essential both for firm-level SBMI as well as for the broader implementation of circular economy processes, little BMI-focused research has addressed the role of collaboration in achieving SBMI (Bocken et al., 2017; Fischer & Pascucci, 2017; Witjes & Lozano, 2016). As Unilever's CEO, Paul Polman, said nearly a decade ago: "The issues we face are so big and the targets are so challenging that we cannot do it alone, so there is a certain humility and a recognition that we need to invite other people in" (Confino, 2012; quoted in Ferraro et al, 2015). There is thus a need for empirical research which examines SBMI in these types of contexts, as collaboration will be key in successfully implementing SBMs and CBMs. Such collaboration will frequently involve heterogenous stakeholders who must develop shared understandings and navigate uncertainty to achieve desired outcomes.

Grounded in philosophical pragmatism (Section 3.1), the dissertation takes a design science research approach to develop tools that can address the design-implementation gap (Section 3.4). The dissertation further presents a case study with elements of action research (Section 3.3.1) to develop a better understanding of the relationships between organizational barriers and drivers, dynamic capabilities, and SBMI, thus expanding our understanding in the literature of organizational factors contributing to the design-implementation gap. The epistemological and methodological choices of the dissertation are justified in the respective sections in light of the dissertation's overarching aim to make not only theoretical and methodological but also practice-oriented contributions to the field.

1.3. Research questions

Considering the design-implementation gap, the lack of good tools for SBMI — particularly when it comes to experimenting with and testing new SBM and CBM ideas, addressing issues around organizational design, or facilitating the kind of

multi-stakeholder collaboration necessary for SBMI — a lack of understanding of how the connections between organizational design, dynamic capabilities, and SBMI play out in particular industry and firm contexts, and the lack of knowledge around how to facilitate SBMI in collaborative contexts, the dissertation addresses one central research question:

RQ: How can firms overcome the design-implementation gap of sustainable business model innovation?

These questions are approached through the development of four peer-reviewed papers, each of which addresses related but distinct research questions which are subsumed under the primary research question and which attempt to cover the various gaps identified above. These research questions are as follows:

Paper I, RQ1: How can the concepts of Responsible Research & Innovation (RRI) and effectuation inform firm-level innovation processes, as well as the forecasting and assessment of sustainability impacts?

Paper II, RQ2: To what extent can Lean Startup and Effectual thinking be combined to support the circular business model innovation process?

Paper III, RQ3: How do organizational design, dynamic capabilities, and sustainable business model innovation interact in the context of an emergent low-carbon offshore aquaculture value chain which places new organizational and capability demands on firms?

Paper IV, RQ4: How can firms address organizational design issues in order to develop the dynamic capabilities necessary for sustainable business model innovation?

As discussed in Section 4, the dissertation ultimately develops multiple tools which can help to bridge the design-implementation gap, while also advancing theory around how organizational barriers and drivers can inhibit or enhance the development of dynamic capabilities needed for SBMI. Figure 1 in Section 1.3 offers a visual representation of the relationship between firms' desire to engage in SBMI, the design-implementation gap, the utility of the right tools, and the importance of

organizational design for achieving desired outcomes. This figure serves as an overview of the dissertation and how the content of the individual papers fit together as a coherent whole.

Looking at the figure, many firms begin at the top left corner with a desire to engage in SBMI and CBMI. However, without access to the right tools (Geissdoerfer et al., 2018; Papers I, II, III & IV) and beset by organizational design challenges and inadequate dynamic capabilities (Bocken & Gerdats., 2020; Papers III & I), they can fall into the design-implementation gap (represented by the arrow at the top of Figure 1). Falling into this gap, attempts to design and implement new business models fail or never get off the ground in the first place, and SBMI and CBMI are unsuccessful (represented by the X in Figure 1).

On the other hand, firms can increase their chances of overcoming the design-implementation gap by proceeding to leverage the right tools (represented by the downward arrow in Figure 1, connecting Desire for SBMI & CBMI to Tools for SBMI & CBMI). Several such tools are developed as part of the dissertation: the Responsible Innovation Tool and Responsible Impact Tool (Paper I); the Circular Experimentation Workbench (Paper II); and Sustainable By Design (Paper IV), as shown in Figure 1. The tools developed in Paper I combine effectuation theory with the concept of responsible innovation, helping firms collaborate for successful sustainability outcomes in evolving multi-stakeholder contexts. The Circular Experimentation Workbench (Paper II) gives firms the ability to develop, experiment with and test circular business model innovations, drawing on a combination of effectuation theory and lean startup. Sustainable By Design (Paper IV) tackles organizational design challenges which can impede firms' abilities to engage in SBMI more broadly. By addressing cultural, strategic and operational barriers and drivers to SBMI, firms can in turn develop the dynamic capabilities needed to sense, seize and transform for sustainability. Leveraged alone or in combination, these tools can help firms avoid falling into the design-implementation gap and succeed with SBMI (as represented in Figure 1).

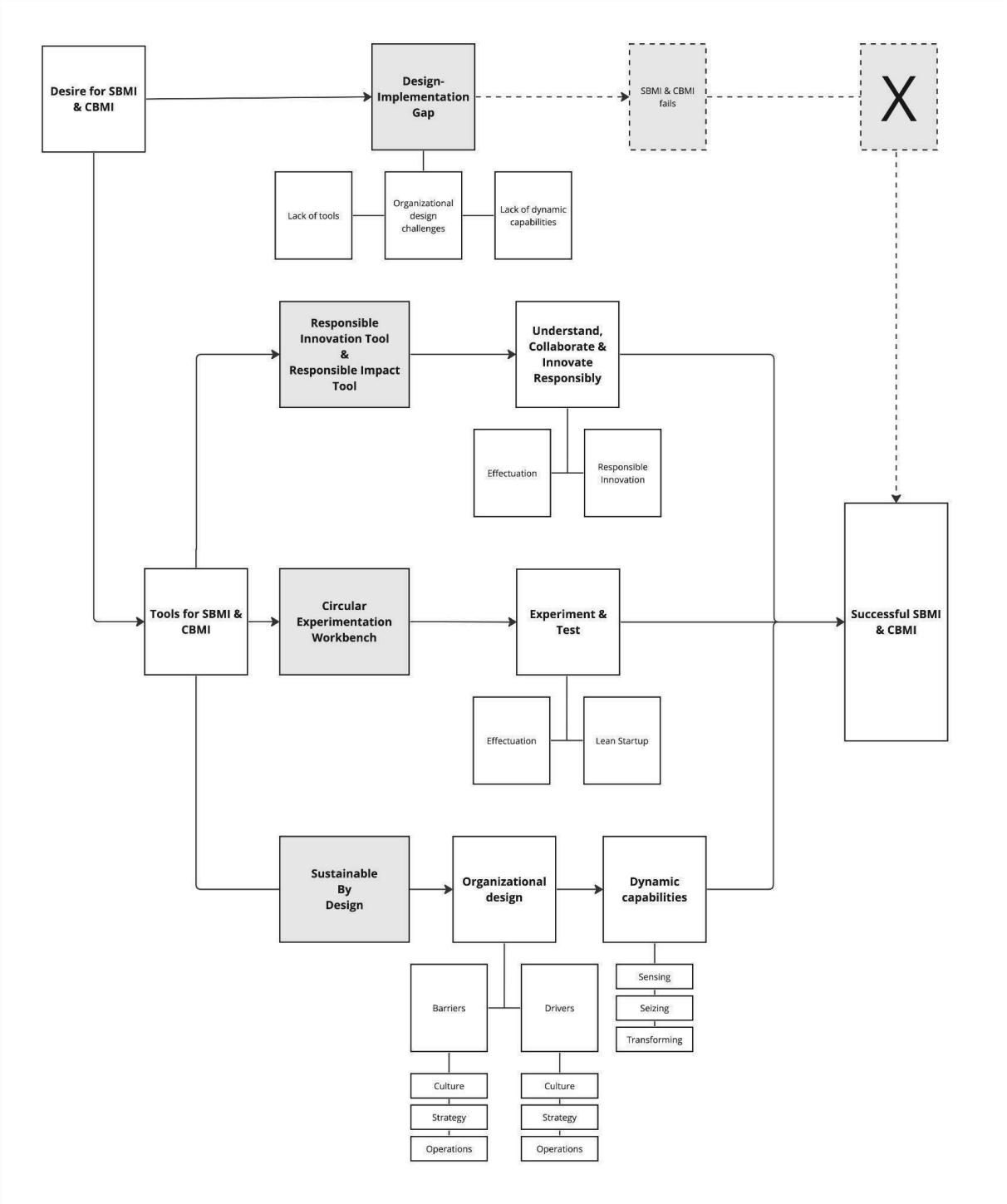

Figure 1. Visual representation of the dissertation, including how concepts are connected.

1.4. Structure of the Dissertation

The dissertation is structured as follows.

Chapter 2 provides conceptual and theoretical grounding and positioning for the topics covered by the dissertation, including sustainable business model innovation; circular business models and the circular economy; effectuation theory; responsible innovation; organizational design; dynamic capabilities; and company culture. In reviewing the state of the art in each of these bodies of literature, the research gaps which the dissertation addresses are clarified further.

Chapter 3 begins with a discussion of philosophical pragmatism — which grounds the dissertation epistemologically — as well as the dissertation's focus on offering relevant outcomes for practice. It then provides background on the context of the empirical case examined in the case study. The chapter then offers an overview of the methods employed in the dissertation, including inductive case study methodology (incorporating aspects of action research) and design science research, the latter of which is used to develop practical tools. It concludes with some reflections on methodological challenges, arguing that despite the potential pitfalls of design science and action research, the need for rapid decarbonization and the transition to a circular economy demand greater engagement from researchers and new approaches to research.

Chapter 4 presents the results from the articles included in the dissertation, including those which emerged from the case study as well as the tools developed in several of the papers. It also offers some reflections on the idea of 'research results' in the context of tool development. It then ties together the conceptual, theoretical, methodological, and empirical content of the dissertation and discusses the project's findings. Highlights include insights regarding the interactions between dynamic capabilities, organizational design, and SBMI; organizational design challenges for SBMI, particularly in complex multi-stakeholder contexts; and the need for new tools for SBMI.

Chapter 5 offers some concluding remarks in light of the results and discussion presented in Chapter 4, summarizing the dissertation's contributions to practice, theory, and methodology. Given the practical orientation of the dissertation, a particular effort is made to not only consider theoretical contributions to the SBMI literature which emerge from the case study and tool development workshops, but

also the practical contributions made by the development of the tools themselves, as well as actionable insights for managers gleaned from the case study context. The section then considers the limitations of the research and concludes with opportunities for future research.

2. Conceptual positioning and theoretical background

This chapter presents and defines some of the key concepts in the dissertation. These concepts are also defined in detail in the articles which comprise the dissertation, but they are examined here independently. In addition to defining these concepts, this section presents the state of the art for those concepts which are most central to the dissertation.

2.1. Sustainable business model innovation

The concept 'sustainable business model innovation' can be understood as being comprised of the component concept 'business model innovation', which in turn is comprised of the component concept 'business model'. To understand what is meant by 'sustainable business model innovation', then, it is helpful to begin with the notion of a business model, proceed to the idea of business model innovation, and finally arrive at sustainable business model innovation. This additive approach to defining the concept is also adopted in Geissdoerfer et al. (2018).

The business model concept first gained traction amongst researchers in the early 2000's, and has since assumed a prominent place in the management literature. Early work by Chesbrough highlighted the importance of business models in driving value creation, rather than a pure focus on product or technology (Chesbrough & Rosenbloom, 2002; Chesbrough, 2007). Teece continued this discussion, suggesting that even the best product innovation would not reach its full potential from a value capture standpoint without careful attention being paid to business model design (Teece, 2010). The idea of a business model has also gained considerable traction amongst practitioners, thanks in large part to the work of Alexander Osterwalder. Building on the work developed in his dissertation (Osterwalder, 2004), Osterwalder & Pigneur's 'business model canvas' (2010) has become one of the most widely utilized tools in both corporate and startup innovation contexts. This growth in popularity on both the researcher and practitioner side has also spurred a wide range of uses and interpretations of the concept, with much discussion in the literature about its actual content and meaning. Over the years, business models have been

characterized as 'processes' (Zott & Amit, 2015) and activity-based 'systems' (Zott & Amit, 2010) emerging in firm contexts. A recent authoritative review by Massa et al. (2017) analyzed 2,754 articles on business models, ultimately concluding that there are three dominant representations of the business model concept present in the literature: the business model as an "[attribute] of real firms"; as a "cognitive/linguistic schema"; and as a "formal conceptual [representation/description] of how an organization functions" (p. 76). Massa et al. (2017) suggest that this range of interpretations of the concept is due to not only the sheer volume of research conducted on the topic over the past two decades, but also the variety of "subject-matter lenses" applied to it in different contexts (p. 76).

Broadly speaking, however, one of the most widely utilized operationalizations of the concept is as the way an organization creates, captures, and delivers value. Throughout this dissertation, it is this simplified notion of value creation, capture, and delivery that underpins my use of the term 'business model'. More specifically, I have regularly returned to the representation provided by Osterwalder & Pigneur's (2010) business model canvas for understanding and thinking about how organizations create, capture, and deliver value. In terms of the schema discussed above from Massa et al. (2017), Osterwalder's interpretation of the business model concept falls into the third category: a conceptual representation of how the firm operates. Massa et al. highlight the characterization of the concept in Osterwalder et al. (2005), which argues that a business model is a "translation of strategic issues, such as strategic positioning and strategic goals, into a conceptual model that explicitly states how the business functions" (Osterwalder et al., 2005, p. 3; quoted in Massa et al., 2017).

The idea of a business model 'canvas' is particularly salient as we transition from thinking about 'business models' to 'business model innovation', as the canvas implies the ability to actively alter existing business models and/or design entirely new ones (more on the modularity and decomposability of business models below). Building on empirical work in Osterwalder (2004), the business model canvas (Osterwalder & Pigneur, 2010) represents a business model in terms of nine component parts (Figure 2). A Value Proposition, or the offering to customers in the

form of a product or service of some kind, forms the core of the business model. Key Activities related to the business model, Key Partners involved in its execution, and Key Resources upon which the business model depends all combine to form the supply side of the business model. Customer Segments who derive value from the value proposition, Customer Relationships which must be nurtured to support the successful consumption of the value proposition by said customers, and Channels through which communication and consumption occur form the demand-side elements of the business model. Finally, all of this is supported by Revenue Streams and a particular Cost Structure.

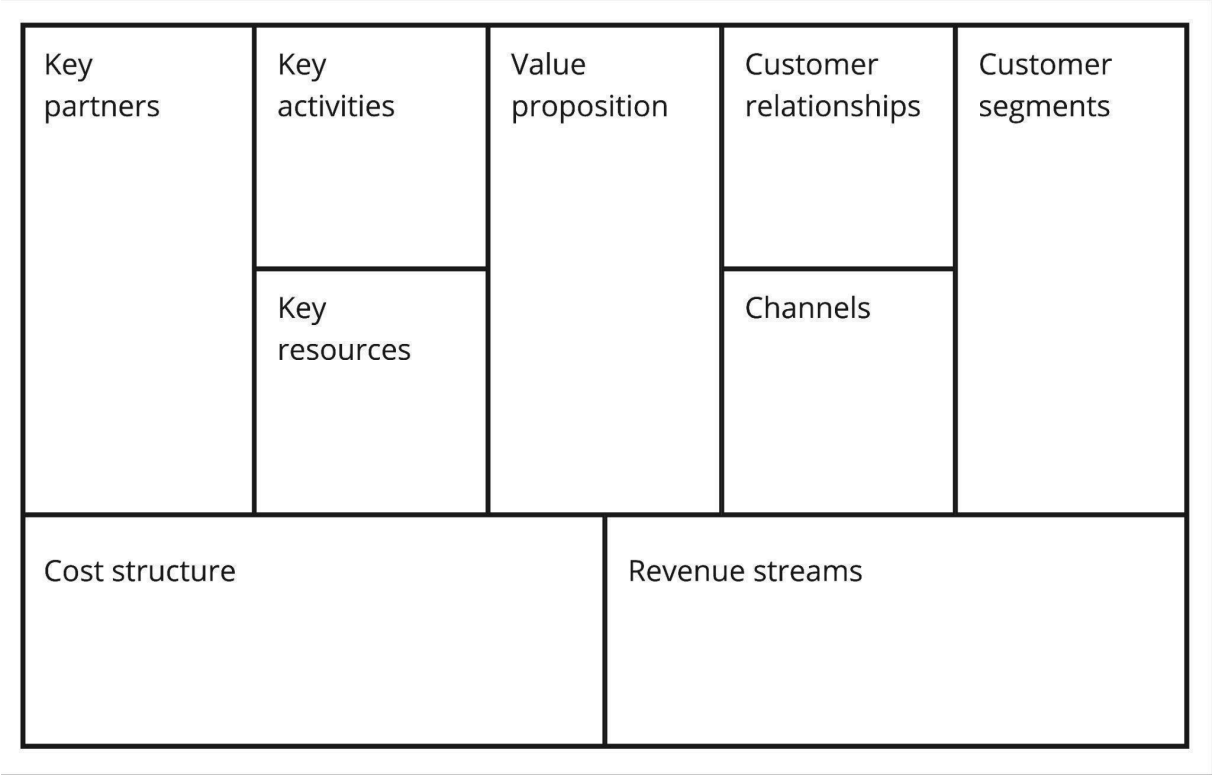

Figure 2. Business model canvas. Adapted from Osterwalder & Pigneur (2010).

If a business model is the way an organization creates, captures, and delivers value, then business model innovation (BMI) is the act of innovating on this process. Foss & Saebi (2017) conduct a literature review of 150 articles relating to the concept of business model innovation, concluding that the literature lacks some of the indicators of a well-developed body of theory (e.g. clear boundaries and explanatory mechanisms). They identify four distinct research streams on BMI: conceptualizing

BMI; BMI as organizational change; BMI as a distinct outcome of firm activity; and the consequences following from firm engagement in BMI. They further develop a framework which captures the "antecedent, moderating, and mediating influences on BMI" (p. 2), attempting to guide future research on the topic. They define business model innovation itself as "designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements" (Foss & Saebi, 2017, p. 2). They further develop a BMI typology, suggesting that BMI can be understood in terms of its novelty (new to a firm or new to an industry) and scope (architectural or modular). The latter is understood in terms of the level of complexity inherent in a particular business model's architecture. Some business models are what Foss & Saebi (2017) term "decomposable": the value creation, capture and delivery mechanisms are highly modular, with relatively few interdependencies that might hinder innovation around any particular module (p. 17). Others are "nondecomposable" in that the value creation, capture, and delivery mechanisms are interconnected in a highly complex system, and wherein any changes to these components of the business model would necessitate "massive architectural change" (p. 17).

Focusing specifically on sustainable business model innovation (discussed further below) and conducting a separate literature review, Geissdoerfer et al. (2018) defines business model innovation as "the conceptualisation and implementation of new business models" (p. 405). This innovation can be incremental or radical. They similarly develop a typology of business mode innovation, suggesting that a company can 1) diversify into new business areas, 2) acquire other companies with different business models, 3) develop new business models alongside current ones, or 4) transform existing business models into entirely new ones (Geissdoerfer et al., 2018).

Following from this understanding of business model innovation as the act of innovating on the value capture, creation, and delivery process, sustainable business model innovation (SBMI) adds a further layer of complexity. The field of research around sustainable business models and sustainable business model innovation has developed in tandem with the broader fields of business models and business model innovation, with substantial growth in recent years (Evans et al., 2017). Stubbs &

Cocklin (2008) initially developed the idea of a 'sustainability business model', wherein environmental and social sustainability become core to a firm's strategy and operations rather than a kind of supplemental consideration. Boons & Lüdeke-Freund (2013) noted that much of the research on 'sustainable innovation' failed to adequately consider the business model perspective, developing a research agenda for the emergent field of SBMI. Through a literature review combined with examples from extant firms, Bocken et al. (2014) further presented a number of sustainable business model 'archetypes' across technological, social, and organizational dimensions. More recently, Geissdoerfer et al. (2018) review more than 100 articles which include some mention of 'business model innovation' and 'sustainable' or 'sustainability', ultimately synthesizing a number of working definitions into the claim that SBMI is "the conceptualisation and implementation of sustainable business models. This can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another" (p. 407). While Geissdoerfer et al. (2018) has become one of the most (if not the most) widely cited papers on the topic, this definition arguably begs the question: it seems problematic to include the word 'sustainable' in a definition of 'sustainable business model innovation.'

Instead, in this dissertation, I opt for the definition of SBMI provided by Bocken et al. (2014):

> "Business model innovations for sustainability are defined as: Innovations that create significant positive and/or significantly reduced negative impacts for the environment and/or society, through changes in the way the organisation and its value-network create, deliver value and capture value (i.e. create economic value) or change their value propositions." (p. 44)

Put more simply, SBMI is about innovating on value creation, capture and delivery in such a way as to create positive (or at least reduce negative) environmental and social impacts. This can mean making changes to an existing business model (incremental SBMI), but it can also entail completely transforming existing business models or creating entirely new ones (more radical SBMI).

As discussed in Section 1.1, there exists a 'design-implementation gap' in the private sector: companies struggle to successfully design and implement new, sustainable business models (Geissdoerfer et al., 2018). One clear reason for this gap is a lack of tools to assist firms in designing and implement new SBMs (Geissdoerfer et al., 2018; Baldassarre et al., 2020). Another is the existence of organizational barriers which hamper firms' ability to successfully develop and launch new SBMs (Bocken & Geradts, 2020).

2.2. Circular economy and circular business model experimentation

When I began the process of conducting research for my doctoral project, 'sustainability' had long since become a buzz word. But during the course of my doctoral work, I have witnessed 'circular economy' go from a relatively peripheral concept to an increasingly mainstream business one, arguably achieving something like buzzword status in certain countries and industry contexts. The two terms, 'sustainability' and 'circularity', are often conflated or used interchangeably — a tendency which is problematic for addressing various environmental and social challenges. As the articles which comprise this dissertation include both a focus on sustainability (e.g. sustainability impacts, Paper I; sustainable business model innovation, Paper III, Paper IV), as well as circular economy and circular business model experimentation (Paper II), it is important to understand how the latter differs from the former, as well as where there is conceptual overlap.

While this is far from a straightforward task, Geissdoerfer et al. (2017) — the most widely cited article on the subject — conducts a thorough literature review of 'circular economy' and 'sustainability', and offers summary definitions which highlight the similarities and differences between the concepts. They define circular economy as "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling" (p. 766). In contrast, sustainability is defined as "the balanced integration of economic performance, social inclusiveness, and environmental resilience, to the benefit of current and future generations" (p. 766). More recently, Konietzko et al. (2020a, 2020b) built on this definition in

combination with Bocken et al. (2016), identifying regenerative approaches as distinct from but comparable with the slowing, closing, and narrowing of resource loops (Figure 3).

The concept of circular economy, therefore, is painted in contrast to that of our current predominantly linear economic paradigm, one which approaches resource use in an extractive fashion, and where the vast majority of resources are taken, used, and ultimately end up as waste. Going from this linear model to a circular one involves narrowing resource use (using less resources), slowing resource use (increasing the life of products and using resources for longer periods of time), closing linear resource streams (using resources and products more than once, effectively creating resource loops), and, following Konietzko et al. (2020a), regenerating resources ("using non-toxic material, renewable energy and [regenerating] natural ecosystems") (p. 2).

Circular business models, therefore, are those which creature, capture, and deliver value for customers by leveraging these techniques of narrowing, slowing, closing, and regenerating resources (Paper II). By contrast, as outlined in Section 2.1, sustainable business models seek to create, capture and deliver value for customers in such a way as to create positive and/or reduce negative impacts on the environment and society. In this way, sustainable business models (and sustainable business model innovation) leverage the 'triple bottom line' approach to economic, environmental, and social sustainability (Elkington, 1999), as echoed in the summary definition of sustainability offered in Geissdoerfer et al. (2017) as "the balanced integration of economic performance, social inclusiveness, and environmental resilience" (p. 766). As noted in Geissdoerfer et al. (2018), some sustainable business models may be circular, and some circular business models may be sustainable; however, circular business models can also be unsustainable (e.g. a business model which regenerates resources but is socially exploitative), while some sustainable business models may not be circular (e.g. a social enterprise which fails to address resource extraction) (Figure 4).

Despite the importance of transitioning to a circular economy in order to reduce our demand on strained resources and transition to an economic system which can

operate within planetary boundaries (Steffen et al., 2015), recent research has concluded that the global economy is only 7.2% circular, and that this number has actually decreased since 2018 (Circle Economy, 2023). Further, despite the potential of circular business models to both capture new value for firms while also reducing environmental footprints, these types of business models are still rare and are just beginning to emerge (Ritala et al., 2018; Santa-Maria et al., 2021). In particular, there is a need for tools which can support firms in experimenting with and piloting circular business models (Bocken et al., 2019b; Pieroni et al., 2019).

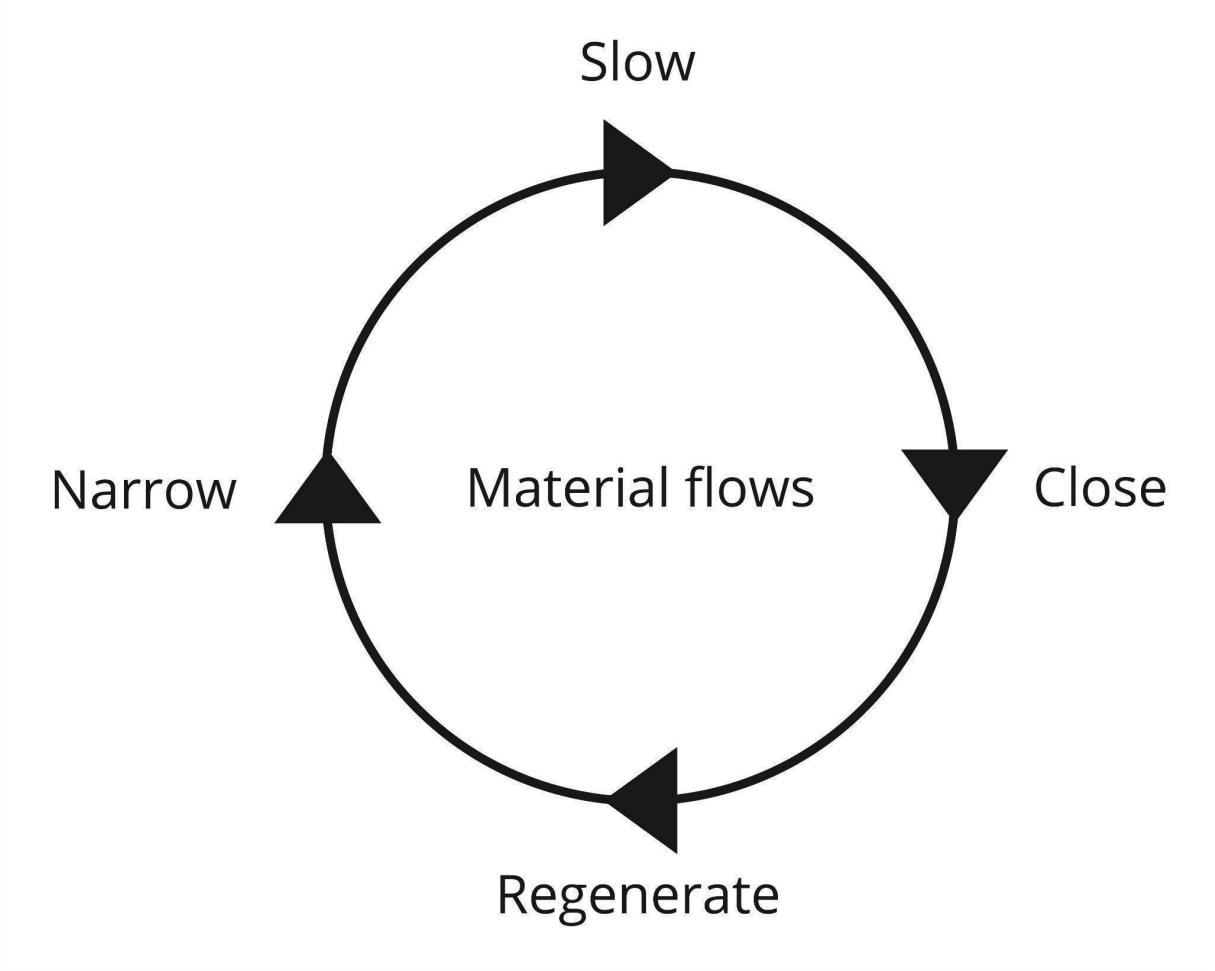

Figure 3. Strategies for material flows in circular business models. Adapted from Konietzko et al. 2020a.

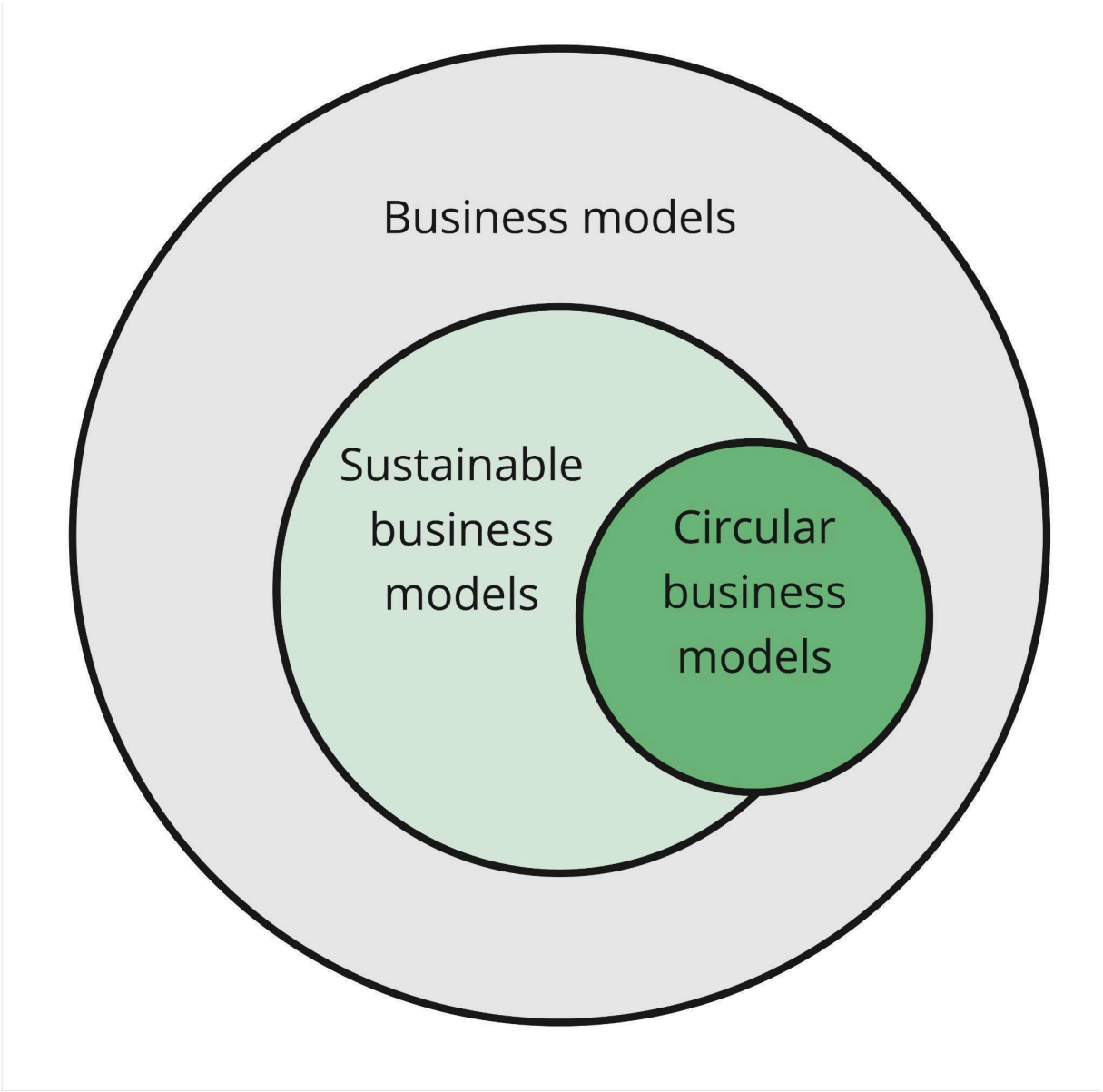

Figure 4. Overlap of conventional, sustainable, and circular business models. Adapted from Geissdoerfer et al. 2018.

2.3. Effectuation

Whether in a corporate venture or startup context, the process of designing and implementing new sustainable and circular business models is itself an act of new venture creation. As mentioned in Section 1.2, this process is far from straightforward and involves considerable complexity. But how exactly do new ventures come into

existence? How do entrepreneurs and corporate innovators do what they do? How do they get from zero to one?

In the entrepreneur context (and we can extrapolate from this to the corporate venture context), the traditional picture goes something like this. An entrepreneur has a brilliant idea. It comes to her suddenly. She sees the commercial potential, and plots the path from where she is now to where she wants to end up. She puts together a business plan which, much like a map, will lead her through the steps of realizing her new entrepreneurial vision: raising funds, building a team, creating a product, and getting that product to customers. The entrepreneur then executes on this vision, following the steps laid out in the business plan. Of course, things don't always proceed quite so neatly, and inevitably there are hiccups along the way — but ultimately, this initial vision and roadmap guide the process.

This picture of new venture creation follows a causal pattern. Causal approaches to new venture creation "take a particular effect as given and focus on selecting between means to create that effect" (Sarasvathy, 2001, p. 245). The means may change, but the effect remains relatively static: in this case, the initial vision of the final product.

There is nothing wrong with thinking about entrepreneurial activity this way. Sometimes it does proceed in more or less this fashion. But we would be wrong to assume that this is how all (or even the majority) of new venture activity actually plays out. Instead, entrepreneurial activity often looks something like this: an entrepreneur has an idea, but isn't sure how to realize it, and remains open to the idea shifting considerably as she attempts to bring it into being. Instead of laying out a roadmap to get to the idea, she looks at the means available to her. Who does she know? She reaches out to her network and starts to build a team. It turns out that the members of this team bring their unique characteristics, backgrounds, and identities to bear on the business idea in unexpected ways. They start to think through how to launch the business using some conventional means, but realize that one of them has access to some kind of atypical resource as part of their network. Perhaps the local innovation ecosystem in which these actors are embedded has certain characteristics which present a particular opportunity, and the co-founders opt to move in that direction, following the path of least resistance. They routinely reassess where they

are and pivot their idea and activity based on what is immediately available to them, rather than clinging to some original roadmap.

This alternative characterization of entrepreneurial activity is what Sarasvathy (2001) terms 'effectuation.' In contrast with causation, effectuated approaches to new venture creation "take a set of means as given and focus on selecting between possible effects that can be created with that set of means" (p. 245). Sarasvathy highlights the primary difference here with a useful metaphor, one which is more concise than the two new venture creation scenarios above. Imagine that a chef will prepare a dinner for some customer. If she were to follow a causal approach, she would design a set menu, choose recipes for the various dishes, go out and purchase the ingredients, obtain any cooking equipment she might be missing, and then prepare the meal for the customer. Alternatively, if she took an effectuation approach, she would look around the kitchen, see what ingredients were in the fridge, poke around in the cupboards for some pots and pans, and just get going with what she had (Sarasvathy, 2001). Neither approach is necessarily superior to the other — but they are fundamentally different, and can lead to very different outcomes.

Since Sarasvathy's seminal paper in 2001, effectuation theory has become a core part of the entrepreneurial literature. It shows up in some infamous instances in practice, too (see e.g. Chen (2021) for a discussion of Slack's pivot from failed computer game startup to the leading choice for internal communication among the world's most innovative companies). Perhaps surprisingly, however, its application in corporate venture contexts is still quite limited both in practice and in the literature (Chesbrough, 2010). It is even less explored in sustainability contexts (Johnson & Hörisch, 2021; Long et al., 2021), where it holds important implications for thinking about sustainability-focused innovation.

2.4. Responsible innovation

In recent years, policymakers have increasingly become aware of the potential dangers and unexpected consequences of innovation activity, contributing to an increase in public conversations around how to approach innovation more responsibly (Stilgoe et al., 2013; Jonas, 1984; Collingridge, 1980; Beck, 1992; Groves,

2006). In the EU context, a literature and broad public policy program has emerged around this idea of 'responsible innovation'. The earliest use of the term in this context comes from von Schomberg (2011), where RRI is defined as a "transparent, interactive process by which societal actors and innovations become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (p. 9). This was later broadened considerably in a seminal paper by Stilgoe et al. (2013), who define responsible innovation as "taking care of the future through collective stewardship of science and innovation in the present" (p. 1570). A recent literature review from Thapa et al. (2019) examines these and other competing definitions, and arrives at a summary one: responsible innovation means "collective stewardship of science and innovation in order to meet the needs and expectation of society and to ensure inclusive, responsible and sustainable development" (p. 2476).

Practically speaking, much of the research in responsible innovation — or responsible research and innovation (RRI), with the terms often being used interchangeably (Jakobsen et al., 2019) — operationalizes (or at least references) a seminal framework proposed by Stilgoe et al. (2013), made up of four dimensions: anticipation, inclusion, reflexivity, and responsiveness. Following Stilgoe et al. (2013), it is through anticipating risks and opportunities, including "new voices" in innovation governance and legitimacy processes, reflexively "holding up a mirror to one's own activities" and "being aware of the limits of knowledge," and responding to "changing circumstances" and shifting stakeholder values that innovation activity can become more responsible (p. 1570-1572). More recently, Jakobsen et al. (2019) have suggested that the literature on responsible innovation must better account for real-world innovation in lieu of a predominant focus on governance of research-based innovation, while also better accounting for how innovation activity might be responsibly shaped in multi-stakeholder contexts, where the triple bottom line of economic, environmental, and social considerations must be accounted for (Elkington, 1999).

2.5. Dynamic capabilities and organizational design

How do firms gain and maintain competitive advantage over other actors in the same industry? The dynamic capabilities theory is one leading attempt in the management literature to account for this phenomenon. It is perhaps easiest to understand when contrasted with a very different way of thinking about competitive advantage, the resource-based view, which held sway within the management literature for decades before dynamic capabilities emerged as an alternative. According to the resource-based view, competitive advantage is a matter of the particular resources which a firm possesses (Penrose, 1959). It is through leveraging these "scarce firm-specific resources" that a firm stays ahead of the competition (Teece, 1997, p. 513). In the 1990's, however, this view no longer seemed capable of explaining competitive advantage in high tech markets, where even firms with a large number of tech resources could be disrupted by smaller, more innovative and flexible firms (Teece, 1997).

Instead, Teece posited that it was through the development of certain 'dynamic capabilities' that firms could stay competitive: namely, the ability "(1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets" (Teece, 2007, p. 1319). It is through these activities of sensing, seizing, and transforming that a company can enter new markets, innovate on its business model, and disrupt strong competitor positions.

Recently, the dynamic capabilities concept has been explicitly linked to business models, business model innovation, and SBMI (Bocken & Geradts, 2020; Teece, 2018; Leih et al., 2015). Teece (2018) suggests, for example, that business model innovation is enhanced by appropriate dynamic capabilities in that a "dynamically capable organization will be able to rapidly implement, test, and refine new and revised business models" (p. 45). However, there is a lack of research which better elucidates how this might work in practice, or how dynamic capabilities can be developed in order to facilitate this type of innovation activity. The same holds true for SBMI (Bocken & Geradts, 2020).

This same stream of literature has also begun to consider how organizational design might enable or inhibit a firm's ability to develop the dynamic capabilities needed for SBMI. Organizational design is about the purposeful configuration of an organization, both in terms of its tangible structure as well as the less tangible institutional norms which comprise it. On the one hand, organizational design can refer to how an organization's "strategy, people, structure and management processes" can be optimally configured (Bocken & Geradts, 2020, p. 3; Burton et al., 2006; Galbraith, 1974; Meyer et al., 1993; Miles & Snow, 1978). A broader definition of the concept can also include an organization's "management philosophy," including the overarching "values, belief, and assumptions" which guide the development and implementation of organizational strategy (Bocken & Geradts, 2020, p. 3; Miles & Snow, 1978; Miles & Creed, 1995). In this sense, organizational design can also be understood as including a cultural component, following the definition of company culture outlined below in Section 2.6 as the underlying values and norms which guide activity in an organizational context (Teece, 1996). Addressing organizational design is a challenging task for larger firms due to thick bureaucracy and lack of alignment between internal actors, incentives, and governance structures (Bocken & Geradts, 2020; Augier and Teece, 2009; Harris and Raviv, 2002; Mintzberg, 1980). Tushman et al. (2010) determined that ambidextrous organizations with more heterogeneity — where innovative "exploration" of new opportunities and "exploitation" of existing business models can exist side-by-side in dedicated internal units — tend to be better at executing on innovation (p. 1331).

Recently, the management literature has begun to explore the connections between organizational design, dynamic capabilities, and (sustainable) business model innovation. Building on Teece's suggestion that "dynamically capable organization will be able to rapidly implement, test, and refine new and revised business models" (2018, p. 45), recent research suggests that organizational design is important for developing these dynamic capabilities in the first place. This implies that in alignment with the observation in Tushman et al. (2010) that certain types of organizational structures can pave the way for innovation, organizational design in general is important for an organization's ability to engage in (sustainable) business model innovation. Leih et al. (2015) argue that sensing new opportunities is

dependent on a company's "structure, incentives, and culture" (p. 1), while Teece (2018) suggests that incentive structures (Ireland et al., 2009) and flat, decentralized organizations (as opposed to hierarchical ones with highly centralized decision making authority) tend to engender the development of dynamic capabilities for business model innovation (Teece, 2018; Foss, 2003). Bocken & Geradts (2020) continue this work by connecting these observations about organizational design and dynamic capabilities with sustainable business model innovation. They conduct an inductive case study in which they identify concrete organizational barriers to and drivers for the development of dynamic capabilities for SBMI. They further group these barriers and drivers into three types: institutional, strategic, and operational. Bocken & Geradts (2020) follow Hoffmann (1999) in characterizing 'institutional' as the "well-established rules, norms, and beliefs that describe the reality for the organization and guide their actions accordingly" (Bocken & Geradts, 2020, p. 6). In this sense, 'institutional' can be read as 'cultural', following the discussion of culture in Section 2.6 where culture is defined as the organizational norms influencing and guiding individual behavior within a firm (Teece, 1996; O'Reilly, 1989; Fiol, 1991). Papers III and IV (which deal with organizational design and these various barriers and drivers) refer to 'cultural' rather than 'institutional' barriers and drivers in order to reduce jargon, make insights more familiar and actionable for managers ('cultural' is a better understood term than 'institutional'), and link up the discussion of Bocken & Geradts (2020) with Teece (2018), Teece (2023), and Leih et al. (2015), all of which address 'cultural' rather than 'institutional' factors that contribute to business model innovation and dynamic capabilities.

This categorization of barriers and drivers as well as their identification and labeling (e.g. a focus on maximizing shareholder value as an institutional barrier, or the ring-fencing of SBMI resources as an operational driver) substantially advances the theory around how organizational design can drive SBMI, as well as the discussion around organizational design in general. However, Bocken & Geradts (2020) point out that more work is needed in this area, including empirical studies which further examine how these barriers and drivers present in particular industry and organizational contexts, as well as their relative importance for SBMI outcomes.

2.6. Company culture, innovation and organizational design

The concept of 'organizational culture' or 'company culture' has seen a range of use and interpretations in the management and organizational literature. This is unsurprising in light of the fact that the concept is borrowed from cultural anthropology, where its nature and meaning are also highly disputed (Smircich, 1983). Teece (1996) offers a simple summary definition of organizational culture as an organization's characteristic norms which guide behavior (c.f. O'Reilly, 1989). Smircich (1983) argued that while culture could be conceived as a "background factor," "organizational variable," or a "metaphor for conceptualizing organization," in each case the concept highlights the experience of the "nonrational" and "expressive" qualities of actors in an organization (p. 355). Allaire & Firsirotu (1984) conducted a survey of how the concept had been used in the literature, comparing these usages to foundational theories of culture in anthropology. This resulted in a conceptual framework where company culture is understood as "a particularistic system of symbols shaped by ambient society and the organization's history, leadership and contingencies, differentially shared, used and modified by actors in the course of acting and making sense out of organizational events" (Allaire & Firsirotu, 1984, p. 216). In other words, the broader society within which a company is embedded has a direct impact on shaping its company culture — but at the same time, company culture is distinct from the broader social culture within which it is embedded. This company culture can be understood in terms of the organization's past, the situation in which it currently finds itself, and the actions (leaders and contributors taking action which actively shape organizational culture) and sensemaking (members of the organization interpreting and internalizing) of actors within the organization. Meanwhile, Fiol (1991) argues that the concept of organizational culture has traditionally been operationalized primarily in two distinct ways in the management and organizational literature, with each approach based in mutually exclusive underlying assumptions. The "culture purist's view" would maintain that company culture emerges from "deep, underlying values," with the objective of research into company culture being to describe this emergence rather than explaining or predicting various phenomena. Meanwhile, the "culture pragmatist's view" has held that culture is a kind of tool which can be leveraged to

drive better organizational outcomes, for example through codifying new organizational values, creating incentive structures, or enforcing new sets of rules aimed at changing behavior (Fiol, 1991, p. 195; Smircich, 1983). Fiol argues for the importance of the "meaning-making processes" which connect the underlying values of the 'purist' view with the more superficial behaviors described by the 'pragmatist' view (1991, p. 196).

More recently, researchers have considered the role of company culture in innovation (both at the product and business model level) and organizational design. Teece (1996) studied the organizational forms which contribute to innovation outcomes, particularly around new technologies. He argues that a handful of cultural norms are particularly salient for innovation contexts, including "the autonomy to try and fail; the right of employees to challenge the status quo," and "open communication to customers, to external technology, and within the firm itself," along with valuing "teamwork, flexibility, trust and hard work" (Teece, 1996, p. 206). These cultural norms are embodied in what he describes as the 'high flex Silicon Valley' archetype (as contrasted with other firm archetypes), where hierarchies are shallow, autonomy is high, functional specialization and top-down seniority are avoided, and communication is quick, open, and informal (Teece, 1996, p. 212-13). Ultimately, in considering which organizational archetypes are best suited to each of six innovation types — including both autonomous innovation (which can take place without major modification to existing equipment or physical components) and systemic innovation (which requires major changes to other parts of an existing system) (Teece, 1996, p. 205), each of which can occur where capabilities exist in the firm, are available outside the firm, or must be created — it is only the Silicon Valley structural archetype (and accompanying cultural norms) which is well suited to both autonomy and systemic innovation when capabilities must be developed from scratch. Though Teece does not use the terminology here (as his seminal 1997 work on dynamic capabilities was still forthcoming at the time of publication), these are in fact dynamic capabilities.

Meanwhile, Tellis et al. (2009) investigated the role of company culture in driving radical innovation outcomes, e.g. the introduction of new products which are

"radically different from existing products in the industry" or leverage "radically new technologies" (p. 19). They found that compared to other variables traditionally assumed to drive radical innovation in firms — including national labor metrics, government regulations, availability of capital, and national culture — corporate culture was a much stronger driver (p. 15). They further found radical innovation to be directly correlated with creating positive financial value for firms, a conclusion they reached by measuring 'radical innovation' via survey data while benchmarking financial performance using public data. This positive correlation existed despite controlling for variables like patents and R&D expenditure. Interestingly and apparently unintentionally, their survey questions prompted firms to consider aspects of company culture which roughly map onto some types of higher order dynamic capabilities such as sensing ("We are slow to detect fundamental shifts in our industry") and seizing ("We are reluctant to engage in untested business ventures") (p. 19). They suggest that those firms which "embrace risk" rather than "averting it" are those which can develop the kind of innovative cultures which in turn will drive radical innovation outcomes (Tellis et al., 2009, p. 16). Further, Bock et al. (2011) looked at how both company culture and structure impacted strategic flexibility when attempting to engage in business model innovation, using a Likert scale survey to rate the degree of creativity in a company's culture. They found that a 'creative' company culture was positively correlated with "outcomes of strategic flexibility" in business model innovation contexts, and further identified similarities between a 'creative' and an 'innovative' company culture (p. 280).

The role of organizational culture in corporate sustainability has recently received some attention in the literature, though this stream of research is still in its infancy. Linnenluecke & Griffiths (2010) consider that a corporate culture strongly aligned with sustainability outcomes would be one in which consensus exists between leadership and employees around "environmental values and beliefs" (Linnenluecke & Griffiths, 2010, p. 362-363; Crane, 1995). These sustainability-focused values would be presumed to trickle down from top management to individual contributors (Linnenluecke & Griffiths, 2010; Hoffman, 1993; Welford, 1995; Dodge, 1997). However, the idea that this is possible in practice has been challenged as representing a "symbolic meaning" instead of a "realistic assessment of an organization's culture"

(Linnenluecke & Griffiths, 2010, p. 363; Harris & Crane, 2002; Howard-Grenville, 2006). Instead, some researchers argue for a so-called 'differentiation perspective' with regard to the integration of sustainability-focused values into broader organizational culture, wherein organizational units display unique subcultures which cohere to greater or lesser degrees with high-level organizational directives around e.g. a sustainability-focused culture (Linnenluecke & Griffiths, 2010; Howard-Grenville, 2006). The significance of this differentiation perspective is discussed in Sections 4.4.1 and 5.3.

3. Epistemology, methodology and case background

This chapter explores the epistemological foundation and methodological approaches taken in the articles which comprise the dissertation. Different methods were chosen for particular papers, and I believe this mixed methodological approach has resulted in the development of insights which would not have emerged from a more univocal approach to methods (e.g. only conducting qualitative case studies). The chapter begins with an overview of the epistemological commitment to pragmatism which grounds the dissertation as a whole. It then continues with a brief discussion of the dissertation's aim to contribute to both theory and practice, before proceeding to discuss the case study approach taken in Paper III, the case context, and the accompanying data collection process. I then proceed to discuss the design science research approach which underlies Paper II and Paper IV, resulting in tools for practitioners. The chapter concludes with some reflections on methodological choices and limitations. See the individual articles for further discussion of the methodologies employed.

3.1. Pragmatism as epistemology

While the dissertation makes a concerted effort to contribute useful insights to practice, one might expect a section on the philosophical underpinnings of the dissertation to focus instead on theory. To some extent it must, but given the epistemological commitment to pragmatism which forms the foundation of this work, this departure is hopefully minimized in the eyes of the reader.

First, some questions. What is knowledge? How can we really say that we 'know' something, and what does it mean to say this? What kinds of things can be the object of knowledge, and how certain can we be about this knowing?

These are the kinds of questions one typically asks when engaged in thinking about epistemology. Derived from the Greek episteme (knowledge) and logos (theory of), epistemology refers to a theory of knowledge: a defensible account of how we know what we know. In order to engage in some kind of scientific inquiry (a doctoral research project, in this case), there must be some operating epistemology in place. In the social sciences, popular approaches include social constructivist or interpretivist

epistemologies, where knowledge is understood as constructed by socially conditioned beliefs, norms, experiences, and values. This is in contrast with varieties of positivist epistemology, wherein knowledge is thought to be derivable from some kind of objective reality, and where individual subjective interpretation is irrelevant for knowledge creation (McBride et al., 2022). Note that both of these epistemological positions rest on ontological ones: that is, on a theory of what is. Constructivist epistemology argues that reality is open to interpretation and actively constructed by our perception of it — there is, in other words, no such thing as an 'objective' reality which is neutral to observation. Positivist epistemologies argue for precisely the opposite: that it is access to this objective, neutral reality which allows for the creation of knowledge. A third and increasingly popular epistemological alternative to traditional positivist and interpretivist/constructivist positions in the social sciences is critical realism, which posits something in between the two: reality does exist as something neutral and independent of our observations of it; however, we can only come to know this 'real' domain through observation of events in an intermediate 'empirical' domain (Bhaskar, 1978).

It is my position that all three of the above approaches to epistemology suffer the same problem: they are too focused on the object of knowledge — objective reality, subjective reality, or critical realism's problematic conflation of the two — rather than on the process of inquiry. I maintain that traditional epistemological approaches simply ask the wrong questions, and therefore contribute little to inquiry. Instead of focusing on what exactly we can come to know (the object of knowledge) and how we might be certain we have arrived at our final destination of certainty about something, we should rather look at how we can improve our process of inquiry to form more useful beliefs about the world: that is, beliefs which better correspond with our experience. This epistemological position, known as philosophical pragmatism, is the one which grounds the research undertaken in this doctoral project.

Instead of making claims about whether knowledge is based in a real world or a subjectively constructed one, philosophical pragmatism shifts the focus to the act of coming to know: that is, the "doing and acting" of inquiry which allows us to come to

know something (McBride et al., 2022, p.127). While traditional epistemological approaches tend to focus on knowledge as an "idealized end-point of human thought," epistemology re-cast in a pragmatist light focuses on inquiry itself, "considered as the process of knowledge-seeking and how we can improve it" (Legg & Hookway, 2021). John Dewey, the father of contemporary American pragmatism, sums this up quite clearly: "knowledge, as an abstract term, is a name for the product of competent inquiries. Apart from this relation, its meaning is so empty that any content or filling may be arbitrarily poured in" (2008, p. 16). Dewey wanted to shift our focus away from the classic philosophical program of how we might arrive at solid, unshakeable knowledge and true beliefs to a better account of how we conduct and improve our process of inquiry. This process typically begins with a problem and the urge to understand, address, and solve it. Inquiry and the resulting knowledge it generates can always be improved, since in attempting to address a problem, inquiry does not arrive at some fixed and unchanging object of knowledge which we might call 'truth'. Instead, Dewey writes, "truth, in final analysis, is the statement of things 'as they are,' not as they are in the inane and desolate void of isolation from human concern, but as they are in a shared and progressive experience" (1978, p. 67).

Pragmatist epistemology is therefore as much a 'theory of inquiry' as it is a 'theory of knowledge.' This focus on inquiry as a process, combined with the acknowledgment that this process can always be improved, lands us squarely in the realm of knowledge inquiry qua experimentation. According to Ansell, pragmatism can be understood as a "philosophy of evolutionary learning [emphasizing] the ability of both individuals and communities to improve their knowledge and problem-solving capacity over time through continuous inquiry, reflection, deliberation and experimentation" (2011, p. 5; quoted in Ferraro et al., 2015).

Indeed, the pragmatist focus on problem-solving further recommends it as an epistemological grounding for research which aims to make real-world impacts. Much of qualitative social scientific research in innovation studies at the doctoral level consists of case studies, where knowledge is obtained through interviews, participant observation, secondary data collection (examination of reports, white papers, articles, websites), and ex-post analysis of this data via triangulation and

inductive coding. The aim of this type of research is first and foremost to make sense of the world, rather than to enact change or solve problems (though the latter can certainly follow by leveraging the results of said research). By contrast, a pragmatist epistemology paves the way for more activist modes of research, including case studies with elements of action research — notably with not just inductive but also abductive elements (Gioia et al., 2013, p. 21; Alvesson & Kärreman, 2007) — and design science research (McBride et al., 2022; Peffers et al., 2007). As discussed in Sections 3.3.1 and 3.4, it is precisely these latter modes of research which characterize this doctoral project. In light of the pragmatist position that "the function of thought is to guide action in the service of solving practical problems," (Gross, 2009, p. 366; quoted in Ferraro et al., 2015), the leveraging of design science methods in particular is quite natural, given that design science aims not to simply understand phenomena (as is the case in traditional qualitative research, including social scientific case study research), but to actively design solutions for human problems.

3.2. Research journey: connecting theory and practice

From the beginning, my aim with the doctoral project was to produce research which would not only make a theoretical contribution to the research field, but which would also be useful for practitioners. Although the project evolved substantially over time, this overarching position guided much of my decision making when it came to choice of methodology. I knew from the beginning that I did not want to simply engage in case study work, but that this would nevertheless be an important part of developing inductive insight into the field. I made a concerted effort when developing and conducting the case study to connect theory with practice, and to look for synergies between the theory which informed the case study and that which informed the development of the tool in Paper IV (e.g. organizational design and dynamic capabilities). Similarly, I was able to draw theoretical connections regarding e.g. effectuation theory between Paper I (a mostly conceptual paper) and Paper II (a design science research paper, see Section 3.4), helping me to connect theory and practice as the dissertation project continued to evolve and new opportunities for research presented themselves.

Indeed, while I was intent on developing practical insights for managers, I recognized the importance of grounding the dissertation in theory, and of digging deeper into the theory at the intersection of entrepreneurship, innovation, new venture creation, and sustainability. This confluence of theory resulted in Paper I. This paper did not leverage a particular methodological approach per se such as a case study or design science research process. Instead, it dug into two important streams of research in this area — effectuation theory and responsible innovation — and argued for a way of combining the two through conceptual synthesis. This paper therefore managed to advance the theoretical foundations of sustainability-focused innovation and new venture creation by bridging responsible innovation with effectuation. This conceptual synthesis also gave rise to two tools, better connecting these theoretical developments with practice. A design science approach could have further developed these tools for managers; however, given the space constraints associated with the article, the decision was made to focus primarily on advancing the theoretical discussion rather than orienting the paper toward practice. These tools and the conceptual-theoretical results of this paper are discussed more in Chapter 4.

Meanwhile, methodologically speaking, Paper II and Paper IV are especially practice-oriented. These papers develop conceptual tools for managers to engage in circular business model experimentation (the former paper) and organizational design for SBMI (the latter paper). Both papers employ a design science research methodology to scientifically develop these tools and ground them in empirical data, a process which is outlined in more detail in Section 3.4.

3.3. The Green Platform Project

I employed a case study methodology with elements of action research for Paper III. This methodological approach is justified and detailed in Section 3.3.1. First, however, I provide background here on the industry context in which the case is based, as well as the innovation project itself in which myself and the second author took an action research role.

The case which we analyze in Paper III involves companies and other actors in the Norwegian salmon aquaculture industry. Aquaculture involves the production of fish

in captivity, either in freshwater or saltwater. In the 1960's and 1970's, Norway pioneered the production of salmon in open net pens in its sheltered fjords (Fløysand & Jakobsen, 2017; Aarset & Jakobsen, 2015). Since then, Norway has become the global leader in farmed salmon production, producing just over half of the world's salmon each year (Furuset, 2022). Revenues are substantial, coming in at over $50 billion in 2020, and with Norway clearly leading the way in terms of the sophistication of its innovation system, research institutions, and value chain from a global perspective (Allied Market Research, 2021; Bergesen & Tveterås, 2019). The value chain itself is also quite complex, involving supplier companies, the production of smolt (immature salmon), grow-out farming in open net opens, transport logistics, and primary and secondary processing, as well as the involvement of various research institutions and government agencies (Figure 5).

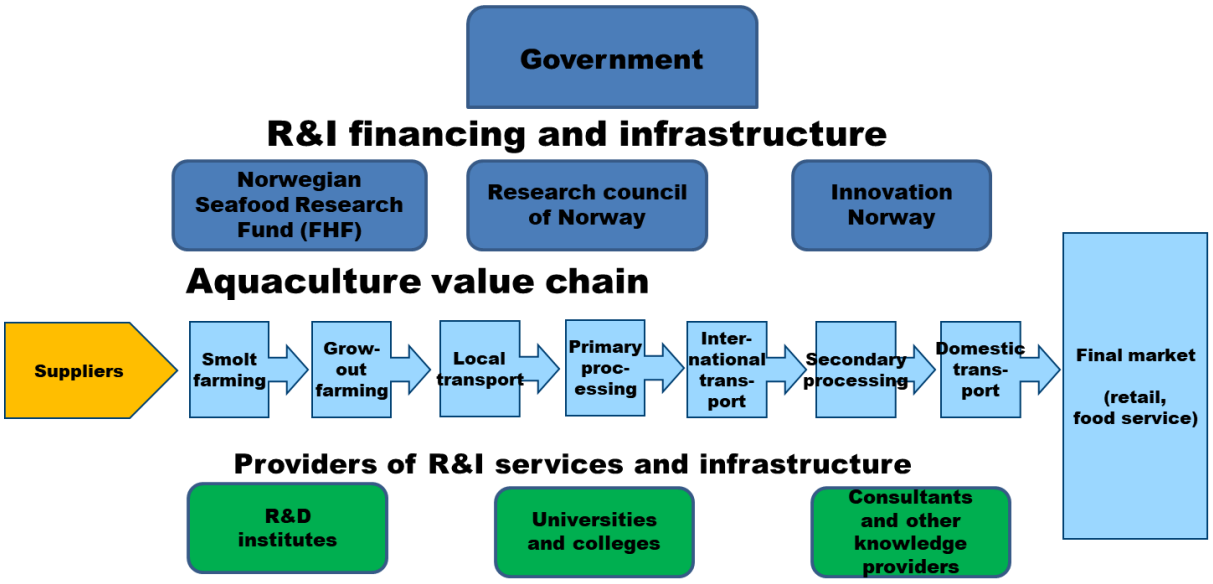

Figure 5. Norwegian salmon aquaculture value chain and supporting institutions. From Paper III. (Source: Bergesen & Tveterås, 2019)

The conventional business model for the largest vertically integrated actors in the Norwegian salmon industry (that is, those which are directly engaged in carrying out most or all of the value chain activities identified above) focuses on growing out

salmon from egg to harvest at scale. Some of these companies also own processing facilities which add value at the final stage of the value chain (e.g. smoking), but in general the focus is on B2B marketing of raw, fresh commodity salmon for the international market. The central value proposition rests on these firms' ability to deliver large amounts of salmon in predictable quantities which can accommodate their buyers' need for predictability and planning (Cojocaru et al., 2021).

In recent years, these traditional business models have been increasingly challenged by rising biological and environmental externalities (Osmundsen et al., 2017). While Norwegian policymakers have called for a 500% increase in seafood production by 2050 (Olafsen et al., 2012), in the near term, central impediments to further growth are the presence of the sea lice parasite, fish diseases and other fish health issues. The sea lice parasite can lead to high mortality rates in traditional net pens, contributing to significant animal welfare concerns. Inshore coastal areas where aquaculture is traditionally conducted are maxed out, with little room for expansion due to sea lice pressure. A high mortality rate can also effectively increase the environmental footprint per kg of edible salmon by a considerable margin. Since the majority of the carbon footprint associated with salmon is embodied in salmon feed sources, and since this footprint occurs upstream in the value chain, a nearly mature salmon which succumbs to sea lice after e.g. two years of growth can effectively be seen as a pure source of emissions with no resulting output. The higher the ratio of unharvestable fish to harvestable fish, the higher the footprint of the total value chain per kg of edible salmon. Additionally, high concentrations of sea lice in coastal waters can lead to impacts on wild salmon populations. The sea lice problem is therefore as much an environmental footprint concern (both in terms of carbon footprint and impact on wild salmon populations) as it is an animal welfare and 'limit to growth' issue. From a longer term perspective, increasing production also runs into a feed bottleneck. Salmon feed relies heavily on both wild fish stocks (in dwindling supply) and land-based soy agriculture. Increased feed production from current sources could therefore result in substantial biodiversity impacts as wild land (e.g. rainforests) are converted to soy production.

Despite these challenges, farmed salmon is still a lower impact animal protein option than beef (20% the CO2 equivalent) or pork (50% the CO2 equivalent) (Poore and Nemecek, 2018; MacLeod et al, 2020), and there is potential to reduce emissions further through the development of new feed sources, electrification of production, and reduction in mortality rates. Since its inception in the 1960's and 1970's, salmon aquaculture has only occurred in sheltered coastal areas (fjords). These farms are exposed to relatively calm waves and currents, and are offered some protection from weather systems. However, production in these areas is at its limit due to sea lice pressure. Meanwhile, so-called 'offshore' aquaculture production (that is, production in areas with significant wave heights averaging more than 4 meters) could potentially address animal welfare and environmental impact concerns associated with sea lice by spreading out production substantially, with individual farming areas spaced further apart in combination with strong currents which could reduce the likelihood of lice spreading from farm to farm. At the same time, over 90% of Norway's economic zone is comprised of 'offshore' waters, and the ability to produce fish in these areas would enable Norwegian companies to increase overall production substantially.

While this sounds appealing from a business perspective, the reality is that shifting from inshore to offshore production challenges virtually every aspect of firms' existing business models and the current inshore value chain. Substantial investments (billions USD) are needed in order to develop new technologies, processes, and business models, while risk is quite high in light of the fact that this production has never been attempted at scale. Additionally, given that it takes three years from egg to harvestable salmon (Salmon Farming Initiative, 2023), there is a substantial delay in return on these investments.

The case examined here, Green Platform (Low Emission Offshore Aquaculture Value Chain), is a public-private research and innovation project which aims to address some of these challenges and develop new innovations through collaboration between research institutions, government agencies, and private firms (Grønn Plattform, 2023). The substantial project funding (approximately $18 million USD) is sourced roughly 50/50 by public entities (Norwegian Research Council, Innovation Norway)

and the participating firms. Public funding is derived from Norway's Green Platform Initiative funding, developed by Norwegian policymakers to hasten the green economic transition in Norway by providing funding for "enterprises and research institutes engaged in green growth and restructuring driven by research and innovation" (Forskningsrådet, 2023). The project's focus is on the development of a new value chain for offshore aquaculture which will not only pave the way for the expansion of the industry in Norway, but also develop innovative solutions which can reduce the overall carbon footprint of salmon production (hence the 'low emission' specification of the project title). The project's work packages cover all aspects of this new value chain, including fish health, digitalization, automation, electrification of production, and feed technology. Participating private sector actors include BluePlanet, Stiim Aqua Cluster, Salmar Aker Ocean, Skretting, Grieg Seafood, FishGlobe, and Hauge Aqua. Some of these firms are quite large multinational companies. Salmar Aker Ocean is a joint venture of Salmar, Norway's second largest salmon producer by market capitalization (with a market cap of over $5 billion USD at the time of writing) (Bloomberg, 2023b) and Aker, one of the world's largest oil companies (market cap of over $48 billion USD at time of writing) (Bloomberg, 2023a), while Skretting is the world's largest producer of feed for farmed fish (The Investor, 2022), producing more than 3 million tons of fish feed per year (Skretting, 2023).

3.3.1 Case study method with elements of action research

It is far from obvious how one might take a scientific approach to analyzing, understanding, and deriving insights from complex human-centered phenomena in the world. In the social sciences, the case study is the most typical way to do this, and qualitative case study work has increasingly gained prominence in the management literature as delivering valuable insights which could not be obtained with other methods. In particular, leading management scholars have recently argued for the value of inductive case study methods in tackling Grand Societal Challenges (GSCs), including those related to environmental sustainability such as climate change and biodiversity loss (Eisenhardt et al., 2016). Ferraro et al. (2015) define GSCs as "complex," "uncertain," and "evaluative": they include many actors and shifting

dynamics; they imply largely unpredictable future states; and they often bring to light new concerns during the process of devising and implementing solutions (p. 365). Eisenhardt et al. (2016) argue that inductive case study methods can handle this complexity well (p. 1115), so long as the research design involved in rigorous and remains grounded in both theory and data (p. 1121).

To ensure the rigor of the case study method employed in Paper III on the one hand while also aiming to derive results which could be applied in practice, we drew on insights from Yin (2013) for general case study best practices, Bocken et al. (2017) and McManners (2015, 2016) for incorporating action research elements, and Gioia et al. (2013) and Locke (2001) for building theory with a grounded inductive approach. Following Yin, we selected the Green Platform project (see Section 3.2.1) as a case due to its uniqueness as well as its potential to lead to unexpected revelatory insights, thus contributing to both theory and practice. Data collection involved the use of semi-structured interviews, participation in dozens of meetings, and review of company reports, white papers, and government commissioned reports. In a typical case study, the researcher aims for a neutral observer role, conducting interviews and attempting to draw ex-post conclusions about some phenomena. In this case, however, both myself and the second author were actively involved in the innovation project which was the object of study. Rather than attempting to remain 'neutral', our aim was to actively contribute to the advancement of the project while attempting to draw insights from it. Unlike standard case study work or applied research, this action research orientation gives the researcher an active role in shaping outcomes, and is "seen as instrumental in the transition to a sustainable world" (Bocken et al., 2017, p. 10; McManners, 2015; Gustavsen, 2008).

At the same time, following Eisenhardt et al. (2016), we were crucially aware of the importance of keeping our research grounded in theory and data. With this in mind, Gioia et al. (2013) and Locke (2001) provided us with best practices for translating our interview data and content analysis into theoretical and practical insights through an inductive grounded theory approach. I stayed close to the primary data throughout the process, while the second author kept his distance from the data, offering periodic feedback on my observations. Interview questions were designed to

be open-ended, avoiding any attempt to keep the conversations too restricted or narrowly focused. I conducted a round of 7 interviews from March to July 2022 (Table 1), representing all of the firms involved in the project (see Section 3.2.1). This was supplemented by participation in more than 50 meetings with project stakeholders, as well as nearly three years of document analysis (Table 2). Taking an inductive grounded theory approach meant that we first analyzed the interviews and assigned open codes to the data. These 1st-order codes were later grouped and aggregated into broader 2nd-order codes, going back and forth between the interview data, meeting observations occurring in real-time, and our review of relevant documents. As things came into focus, we followed Gioia et al. (2013) in shifting from a purely inductive approach to an "abductive" one (Alvesson & Kärreman, 2007), going back and forth between our data on the one hand and existing theory pertaining to organizational design, dynamic capabilities, and SBMI on the other. This ultimately led to further categorization of the 2nd-order codes into aggregate themes and the development of new theoretical contributions as well as insights for practitioners.

Table 1. Data collection table: interviews (Paper III).

#	**Source**	**Company**	**Position**	**Date**	**Length**
1	Interview	BluePlanet / Stiim Aqua Cluster	Senior Manager	Apr 8, 2022	1 hour
2	Interview	SalmarAkerOcean	Business Analyst	May 10, 2022	1.25 hours
3	Interview	Skretting	Sustainability & Public Affairs	May 12, 2022	1 hour
4	Interview	Grieg Seafood	R&D Manager	May 16, 2022	1.5 hours
5	Interview	FishGlobe	General Manager	May 23, 2022	45 mins
6	Interview	Skretting	Marketing & Sustainability	May 27, 2022	1 hour
7	Interview	Moreld Aqua	Digitalization	May 27, 2022	1 hour

Table 2. Data collection table: meetings (Paper III).

#	Source	Type	Date	Length
	Meeting	Two funding application preparation meetings between consortium companies	Mar 11 and Apr 12, 2021	2 hours each
	Meeting	Presentation of Green project to Ministry of Industry, Trade and Fisheries by all consortium partners	June 14, 2021	1 hour
	Meeting	Green platform consortium interviewed by government funding agencies	July 1, 2021	1 hour
	Meeting	Project preparation meeting between all consortium partners	Sep 22, 2021	2 hours
	Meeting	Eight Green platform steering group meetings	Nov 12 to Jan 7, 2022	1 hour each
	Meeting	Digital kickoff meeting all consortium partners	Jan 11, 2022	4 hours
	Meeting	Four Green platform steering group meetings	Jan 14 to Feb 18, 2022	1 hour each
	Meeting	Physical kickoff meeting all consortium partners and external stakeholders	Mar 15-16, 2022	2 workdays
	Meeting	Twelve Green platform steering group meetings	Mar 25 to Oct 21, 2022	1 hour each
	Meeting	Green platform webinar on Responsible Innovation Lab	May 5, 2022	1 hour
	Meeting	Green platform webinar on Responsible Innovation Lab	Jun 6, 2022	1 hour
	Meeting	Green platform webinar on Responsible Innovation Lab	Jun 16, 2022	1 hour
	Meeting	Physical meeting all consortium partners and external stakeholders	Nov 7, 2022	7 hours
	Meeting	Four Green platform steering group meetings	Nov 18 to Jan 27, 2023	1 hour each
	Meeting	Approximately 50 meetings with one or more partners on different issues	Sep 1, 2021- Jan 25, 2023	1 hour each

3.4. Design science research

Empirical research in the social sciences is typically concerned with better understanding and offering an explanation for some phenomena we observe in the world. This is ultimately the purpose of the theories, models, and methods employed in the social sciences. At the doctoral level, much of the value of empirical work is understood to be for the purpose of theory building. By conducting a case study, for example, one is able to abstract something from the case which can be generalized into other contexts, and it is through this generalization that theory can be built (Whetten, 1989). Recently, Sandberg & Alvesson (2021) attempt to expand this way of thinking about theory: in addition to being explanatory, theory can also assist us with 'comprehending', 'ordering', 'enacting', and 'provoking'.

Building theory is a worthwhile endeavor: it is how a research field advances, and how new fields such as sustainable business model innovation are developed (see Section 2.1). Still, whether following the Whetten (1989) or Sandberg & Alvesson (2021) lines of thinking, I would maintain that the development of theory is not *primarily* about designing solutions for real-world problems. Some might respond that this is a banal point, as designing solutions for problems is not what scientific progress is about, including in the social sciences. Perhaps that is true according to a narrow interpretation of 'science'. But what about computer science or information systems (IS)? Certainly a primary focus of research in these fields is the designing of solutions to problems that we encounter in the real world. It is no surprise then that the latter field of IS spurred a research method specifically aimed at just this: design science research (March & Smith, 1995; Peffers et al., 2007; Osterwalder, 2004). March & Smith (1995) contrast design science with the natural and social sciences in terms of its focus on designing things which "serve human purposes" (Osterwalder, 2004, p. 4). Sarasvathy, the originator of the effectuation concept discussed in Section 2.3, has long argued for an understanding of entrepreneurship itself as a kind of design science, drawing on Herbert Simon's seminal The Sciences of the Artificial (1996) to make this argument (Sarasvathy, 2003; Seckler et al., 2021). This line of thought has recently been expanded in e.g. Berglund et al. (2020), where entrepreneurial ventures are conceptualized in terms of extant artifacts which

"iteratively develop at the interface between organized individuals and their environments" (p. 1).

Design science research as a methodology has recently gained increasing traction amongst researchers in the management literature who seek to design tools which can be leveraged by practitioners for addressing problems in the real world (see e.g. Baldassarre et al., 2020), following a process method first described in Peffers et al. (2007). This methodology involves the identification of a problem; the definition of a solution to this problem and the objectives on which the solution ought to deliver; the design and development of the solution; demonstration of the solution; evaluation of the solution in terms of how successfully it solves the problem first identified; further design iterations as needed to improve upon the solution, followed by more rounds of demonstration and evaluation; and, finally, communication of the solution (e.g. in a peer-reviewed academic publication). Both Paper II and Paper IV leverage this approach. The approach as employed specifically in Paper II is presented in Figure 6, while the design science approach of Paper IV is presented in Figure 7.

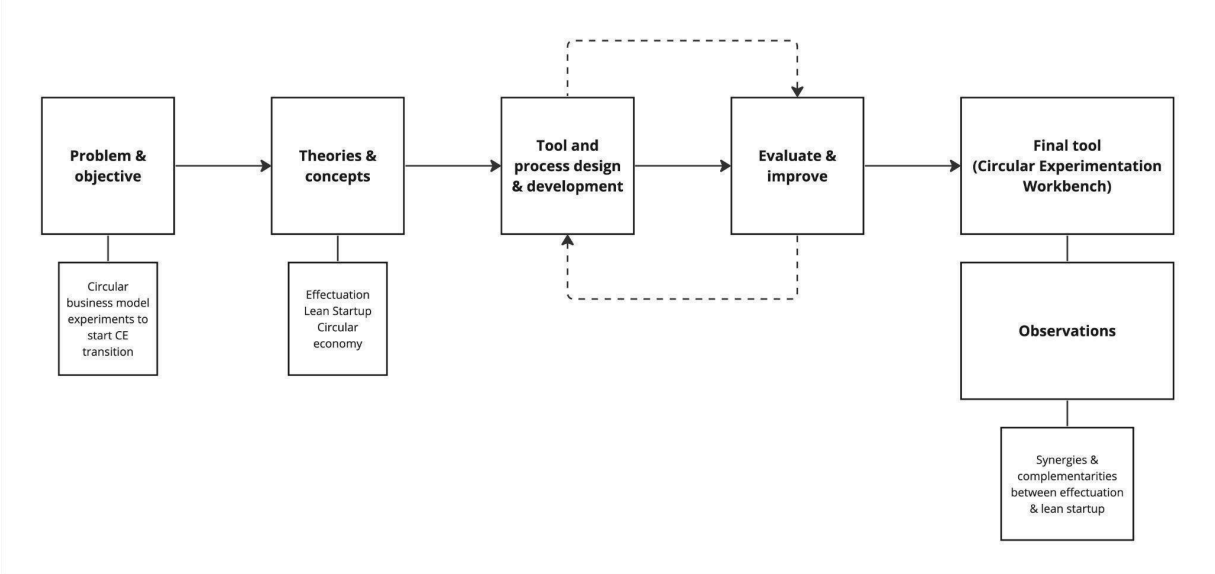

Figure 6. Overview of the design science research (DSR) method, specifically as used in Paper II. 'CE' refers to circular economy. Adapted from Peffers et al. (2007), Buckl et al. (2013).

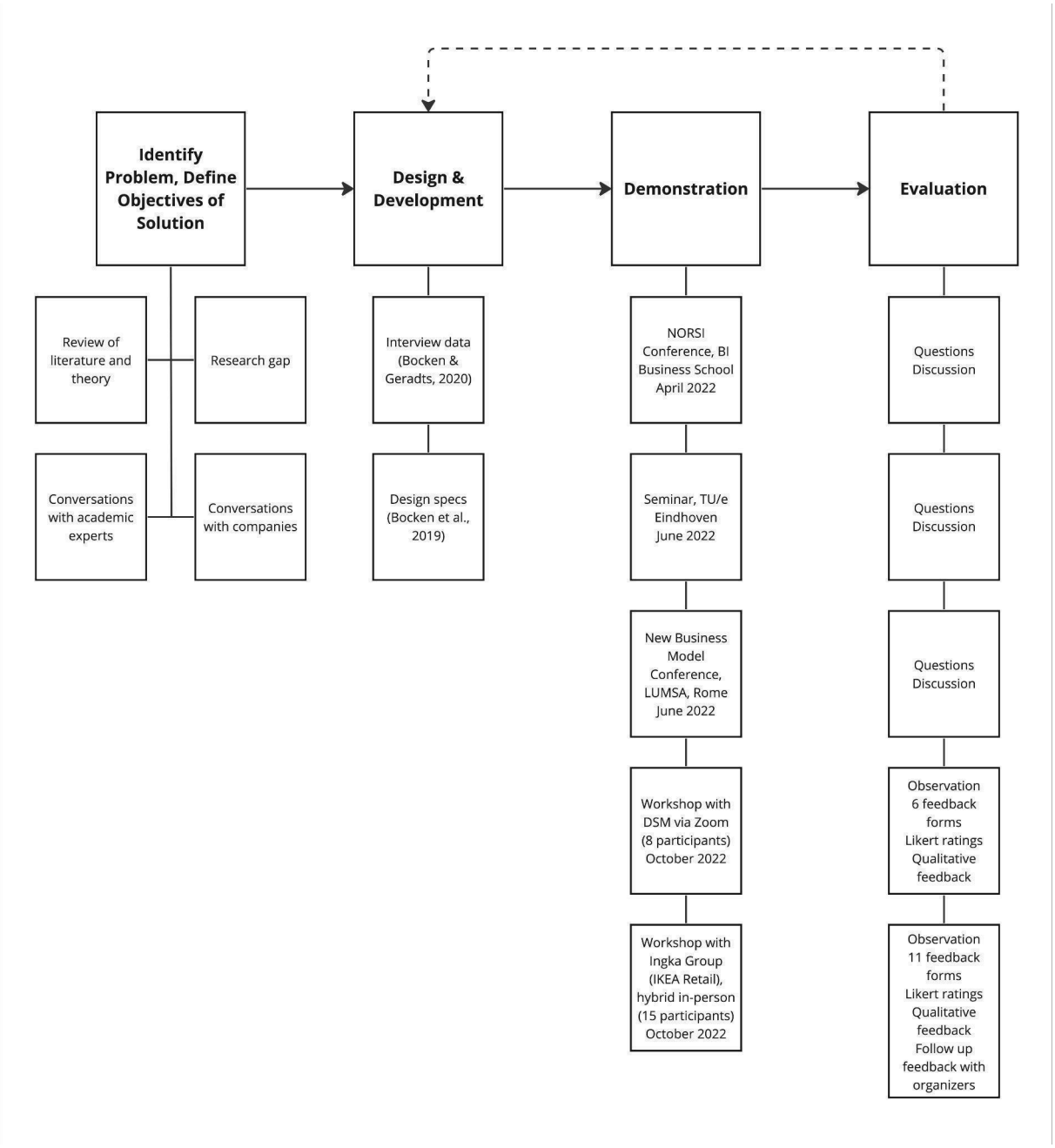

Figure 7. Overview of the design science research (DSR) method, specifically as used in Paper IV. Adapted from Peffers et al. (2007), Baldassarre et al. (2020)

Paper II was developed and published prior to Paper IV, and readers can observe an evolution in the depth of description of the design science process from the former to the latter. Importantly, Figure 7 in particular demonstrates the rigor with which this process is deployed in an academic research context. The problem identification and solution definition phase involves a review of relevant literature and theory, conversations with academic experts, and interaction with companies, all of which

ultimately contributes to the identification of a research-practice gap which the tool can fill. Design and development involves the inclusion of empirical insights from the literature: in the case of Paper IV, for example, this comes in part from Bocken & Geradts (2020). Further, the design process is grounded in best practices identified in Bocken et al. (2019b): the tool must be purpose-made, rigorously grounded in literature and practice, iteratively developed, tested with practitioners, accompanied by transparent guidance and procedure, simple and clear wherever possible, and adaptable to multiple contexts. It is then through demonstration in both academic and practitioner environments that the tool is evaluated with both verbal and written feedback, including qualitative as well as Likert scale responses. This data can then be used to improve the tool as part of the iterative design process.

As described in Figure 6 and Figure 7, a series of workshops were conducted to design, demonstrate, test, evaluate, and iterate on the tools developed. Paper II involved a total of ten workshops, while Paper IV involved five (including three presentations with participant feedback and two workshops with practitioners). These workshops are described in Table 3 (Paper II) and Table 4 (Paper IV). Participants were presented with questionnaires following each workshop which included both a quantitative (Likert scale) and qualitative component to solicit feedback on the tool and workshop process, which could then be used improve the tools. These quantitative and qualitative results are presented in Section 4.3.

Table 3. Data collection table: design science workshops (Paper II).

#	Workshop	Place and time	Lean Startup elements	Effectual elements	Circular economy elements
Iterations					

1	Workshop with businesses of different sizes (~50 participants)	Finland, May 2016	Prompt about what lean startup is; Hypothesis development, testing measures, and success criteria to create new circular business ideas, in low cost and iterative way	Prompts about who they are, what they know, what they have	Industry examples, Prioritise according to impact (vs feasibility), sustainable business model canvas
2	Workshop with PhD researchers in circular economy (~20 participants)	Denmark, November 2017	Prompt about what lean startup is; Hypothesis development, testing measures, and success criteria to create new circular business ideas, in low cost and iterative way	Prompts about low cost and using available means and resources	Industry examples, Prioritize according to impact (vs feasibility, sustainable business model canvas
3	Workshop with PhD researchers in circular economy (~20 participants)	Denmark, November 2018	Prompt about what lean startup is; Hypothesis development, testing measures, and success criteria to create new circular business ideas, in low	Prompts about low cost and using available means and resources	Industry examples, Prioritize according to impact (vs feasibility), sustainable business model canvas

			cost and iterative way		
4	Workshop with 40 international business managers	UK, April 2019	Prompts about iteratively improving the value proposition; deliberate learning through value proposition iterations; low cost testing	Working with stakeholders more effectively and efficiently to collaboratively address societal issues	Sustainable business model canvas, value mapping tool, sustainability idea cards; prioritize according to impact (vs feasibility)
5	Workshop with ~25 European entrepreneurs	Sweden, October 2019	Prompts about iteratively improving the value proposition	Own perspective, Ecosystems and stakeholder perspective, how to be the 'pilot in the plane' (influence the ecosystem)	Circularity card deck with industry examples; conscious mapping of synergies between customer and circular economy proposition
6	Workshop with 5 business participants of same company *(sustainable scale-up)*	Netherlands, December 2020	Hypothesis development, testing measures, and success criteria to create new circular business ideas, in low cost and iterative way	Questions: Who are you and what is your role? What drives you? What data do they have as a starting point?	Industry examples; prioritize according to impact (vs feasibility)

7	Workshop with 3 business participants of same company *(sustainable scale-up)*	Virtual, June 2021	Hypothesis development, testing measures, and success criteria to create new circular business ideas, in low cost and iterative way	Prompts about low cost and using available means and resources	Industry examples; Circularity card deck; ask to prioritise most impactful examples
Final tool					
8	Workshop with 18 business participants *(innovators in circular economy, globally)*	Virtual, February 2022	Explain principles of lean startup. Hypothesis development, testing measures, and success criteria to create new circular business ideas, in low cost and iterative way	Explain principles of effectuation explicitly. Added: (1) Who they are and how they contribute to shaping the future; (2) What they can accept to lose, (3) Whom they know (4) What they can influence with whom (5)	Industry examples; Circularity card deck
9	Workshop with 13 business participants *(innovators and consultants in circular*	Virtual, June 2022	Same as above	Same as above	Same as above

	economy, globally)				
10	Workshop with 16 business participants *(innovators in circular economy, globally*)	Virtual, July 2022	Same as above	Same as above	Same as above

Table 4. Data collection table: design science workshops (Paper IV).

#	**Description**	**Date & Location**	**Participants**	**New elements added post-workshop**	**Steps in Figure 7**
1	Presentation at academic conference	Apr 22, 2022 BI Business School, NORSI conference Oslo, Norway	Academic: PhD students, academic researchers	No changes; validation of concept	Demonstration & Evaluation
2	Presentation at seminar	Jun 9, 2022 TU/e Eindhoven, Netherlands	Academic: PhD students, academic researchers	No changes	Demonstration & Evaluation
3	Presentation at academic conference	Jun 24, 2022 LUMSA University New Business Models Conference Rome, Italy	Academic: PhD students, academic researchers	Facilitation changes: Clear communication of sustainability elements in cards	Demonstration & Evaluation
4	Workshop with managers from different business areas	Oct 17, 2022 Online (Zoom)	Sustainability ambassador, portfolio managers,	Facilitation changes: Guidance on next steps post-workshop	Demonstration & Evaluation

	of DSM (8 participants)		innovation directors	Clearer guidance on focus in breakout groups to eliminate confusion around overlapping content (Culture vs. Strategy vs. Operations) Longer and more frequent breaks in workshop process	
5	Workshop with managers from sustainability, circularity, risk, compliance, strategy, and investment business areas of Ingka Group (15 participants)	Oct 25, 2022 IKEA Retail (Ingka Group) Malmö, Sweden	Circular strategy, sustainability managers / specialists / process leaders, ERM specialist, global ESG, circular leader	No changes	Demonstration & Evaluation

3.5. Methodological reflections

As a doctoral researcher, attempting to balance the development of theory and the advancement of the research field on the one hand with the development of practical insights on the other presented some challenges. It is worth reflecting briefly on these before proceeding to present the empirical results from the articles which comprise the dissertation.

First, the challenges presented by case study research which includes elements of action research are quite obvious: how does one maintain enough distance from the data to achieve some level of 'neutrality' in its interpretation and presentation? There is no straightforward answer to this question. I think the best one can do is acknowledge this challenge from the outset and try to maintain some level of awareness of one's own involvement and investment in the case context. In the case of Paper III, an additional tactic was to bring on additional authors who were not directly involved in the project to offer feedback on the analysis and write-up of the case. This proved to be quite helpful, as I realized at various points that I had

overlooked certain details which seemed obvious to me (because of my embedding in the case context) but which were not actually obvious to an external observer.

At the same time, I would maintain that while an action research-type case study is not without its challenges, it is in no way inadequately scientific or 'objective' by design. Indeed, as described in Section 3.3, there is increasing awareness amongst management scholars that inductive case studies are particularly appropriate for addressing Grand Societal Challenges (Eisenhardt et al., 2016), and a growing number of action research-informed case studies which aim to address these urgent challenges (e.g. Bocken et al., 2017; McManners, 2015). Similarly, my decision to leverage a design science research approach for Paper II and Paper IV was largely grounded in a desire to balance the development of and contribution to theory in the dissertation with the development of practical tools which can address the pressing sustainability and circularity challenges that companies currently face. This was instrumental in addressing the core research gap of the dissertation: namely, bridging the design-implementation gap of sustainable business model innovation.

While combining an action-research based case study with design science research was not without its challenges, it is my hope that in doing so the dissertation manages to make a meaningful contribution to the field of research while simultaneously resulting in useful tools and insights for managers. This focus and outcome is in alignment with the stated purpose of the RESINNREG (Responsible Innovation and Regional Development) doctoral program in which I was enrolled, which states that enrolled candidates should learn "how to act as change agents" and to both "understand and engage in innovation processes related to green innovation, industry innovation, and the public sector" (Western Norway University of Applied Sciences, n.d.).

4. Results and discussion

This chapter of the dissertation presents a summary of the results in the articles which comprise the dissertation. It begins with a note on tools as a type of 'research result', and then proceeds to present the results of the case study (Paper III) and tool-focused articles (Paper I, Paper II, Paper IV). The chapter then proceeds to a discussion of these results within the broader context of the dissertation, incorporating additional theoretical and conceptual results related to effectuation from Paper I as well as theoretical insights from the case study (Paper III). The chapter concludes with a summary of the results and discussion, offering a concise answer to each of the research questions posed in the articles which comprise the doctoral project.

4.1. A note on tools and 'research results'

Before proceeding to present the results of the research papers which comprise the dissertation, I would like to briefly consider the idea of tools and their development process as a type of research finding.

We typically think of research results in the social sciences as those observations and conclusions which derived from e.g. interviews and their subsequent analysis. In addition to these kinds of findings (as presented in Section 4.2.), however, I consider the tools which emerged from Paper I, Paper II and Paper IV as research results in themselves. Particularly in the case of Paper II and Paper IV, these tools can be considered 'results' in the sense that they resulted from a detailed and rigorous scientifically-based methodological process: that is, the design science research method outlined in Section 3.4.

While the tools themselves can be considered a type of 'research finding', the actual process of developing the tools — in particular, working directly with practitioners to test and evaluate the tools themselves — itself led to additional research results. These are presented as 'propositions' in Section 4.2 of Paper II and as 'lessons' in Section 5 of Paper IV, and are also summarized below in Section 4.3.

4.2. Case study results

Based on the interview data, meeting participation, and triangulation with secondary sources, the case study initially resulted in the identification of 32 concepts (1st-order concepts) related to SBMI. 30 of these were then distilled into 10 key 2nd-order concepts, which themselves were further categorized according to two key themes: barriers to SBMI and drivers for SBMI. The barriers and drivers are summarized in Table 5. Two of the 1st-order concepts did not fit neatly into either of these key themes, and were thus grouped under a third theme, 'confounding factors'. These 1st-order concepts were 1) 'culture of innovation' and 2) 'sustainability as a core value.'

Table 5. Barriers and drivers to SBMI identified in case study. From Paper III.

Type	**Barriers**	**Drivers**
Cultural	Cultural ambiguity	Valuing business sustainability
Strategic	Dominant focus on exploitation	Collaborative innovation
	Collaborative challenges	Patient investments
	Cognitive challenges	Public-private collaboration
Operational	Fixed resource planning and allocation	People capability development

Six of the barriers and drivers observed in the case context were synonymous with those found in the Bocken & Geradts (2020) case study, which lays out 13 pairs of organizational barriers and drivers which either inhibit or facilitate the development of the dynamic capabilities needed for SBMI. In addition to these six, we identified four unique barriers and drivers: cultural ambiguity (cultural barrier), collaborative challenges (strategic barriers), cognitive challenges (strategic barrier), and public-private collaboration (strategic driver).

We further observed how culture impacted strategy, which in turn had an effect on operations. The barrier of cultural ambiguity around sustainability resulted in a

number of strategic barriers such as the dominant focus on exploitation, collaborative challenges, and cognitive challenges. These in turn contributed to fixed resource planning and allocation, an operational barrier. Similarly, in other contexts, the cultural driver of valuing business sustainability contributed to the existence of strategic drivers like collaborative innovation, patient investments, and public-private collaboration, all of which led to the operational driver of people capability development.

Lastly, although one might assume these barriers and drivers to be mutually exclusive (e.g. collaborative challenges as a strategic barrier and collaborative innovation as a strategic driver), we observed that these barriers and drivers are in fact not mutually exclusive, but existed simultaneously not only within the project broadly, but within individual organizations. The dynamic tension between what could superficially appear to be mutually exclusive barriers and drivers creates considerable complexity in attempting to understand, assess, and act on organizational barriers and drivers, which in turns creates challenges for addressing the organizational design issues which can inhibit the development of the dynamic capabilities needed for SBMI.

4.3. Tool development results

A total of four tools were developed during the PhD period across three papers: Paper I, Paper II and Paper IV.

Paper I develops two tools which connect responsible innovation with effectuation theory, the Responsible Innovation Tool (Figure 8) and Responsible Impact Tool (Figure 9).

Responsible Innovation Tool

Anticipate	Include	Reflect	Respond
Means *What resources do we have? What knowledge and technology can we leverage? What are our strengths & weaknesses as organizations and individuals?*	**Adoption** *How can we leverage our resources to increase adoption of the innovation?*	**Outcomes** *How does the innovation create sustainability impacts? Are we tied to causal thinking? How much loss is affordable, and for whom?*	**Emergence** *Where do we see new opportunities for sustainability impact? For innovation?*
Partners *What expertise do we have? Who is in our individual/organizational networks? What expertise can they offer?*	**Governance** *Who is involved in governance of the project/innovation(s)? How can we Who can we ally ourselves with to make governance more inclusive?*	**Perceptions** *How do we conceptualize sustainability and responsibility differently as organizations and individuals? How does this impact innovation activity?*	**Pivoting** *How do we seize new opportunities? Where can we form new alliances across organizational boundaries?*
Dilemmas *What dilemmas and trade-offs exist between organizational missions? Where is there competition? What can we control? What can we bracket?*	**Framing** *Who frames the discussion around sustainability? Who is excluded? Where are conflicts emerging?*	**Legitimation** *Where can we create opportunities to foster legitimation of the innovation?*	**Opportunities** *What have we learned about each other than can be leveraged? How can new opportunities be co-created?*

Figure 8. Responsible Innovation Tool. From Paper I.

Responsible Impact Tool

	Impact Forecasting	Impact Assessment	Impact Action
Anticipate	*Where can we create opportunities for impact? What do we bring to the table as organizations and individuals?*	*How flexible is our thinking about impact assessment? Can it adapt to changes and new opportunities? How can we stay open to new opportunities for impact? How will we track, monitor, and evaluate impact?*	*What actions will we be able to take based on our forecasting and assessment activities? How can these actions make a net positive / regenerative impact?*
Include	*Who are we including in this process? Where are there knowledge gaps? Where can we form new alliances and bring in new talent?*	*What stakeholders are responsible for impact assessment? Who is excluded? How do we navigate conflicts and foster inclusion?*	*Which key stakeholders should we include in taking action for impact?*
Reflect	*How much flexibility exists with our approach to impact forecasting? Are we locking ourselves in? Are we stuck in causal thinking?*	*What trade-offs and assumptions exist for impact assessment? What can we control and what can we bracket? How can we make our practices more effective and less invasive? Could the act of measuring affect our results?*	*How effective are the actions we take for impact? Are our forecasting and assessment activities driving meaningful action for impact? Do we need to divert more resources to taking action?*
Respond	*What opportunities are emerging as we collaborate? How can we create space to identify, co-create, and seize new impact opportunities?*	*How can the method of impact assessment adapt and shift when new impact opportunities emerge? Is there lock-in?*	*How can we leverage new insights gained from forecasting and assessment processes to drive action?*

Figure 9. Responsible Impact Tool. From Paper I.

Both of these tools were designed for use in a Responsible Innovation Lab (RIL). The RIL concept is developed in Paper I as a synthesis of the living lab concept with effectuation theory and the responsible innovation literature. Living labs are both a "user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts" (Eriksson et al., 2006,

n.p.) and an “innovative research approach aimed at developing and testing new technologies and strategies to cope with complex social problems” (Nesti, 2018, p. 313; Mitchell, 2003). In a RIL, a variety of stakeholders including actors from universities, research institutions, private companies, government agencies, and NGOs work together to engage in innovation activity which is intentionally linked to desired sustainability outcomes. Innovation activity is therefore shaped by a focus on the responsible innovation principles of anticipation, inclusion, reflexivity, and responsiveness, and emphasizes the importance of ongoing experimentation guided by the utilization of tools such as the Responsible Innovation Tool and Responsible Impact Tool. The former guides innovation activity more broadly, while the latter contributes to the development of context-specific methods of impact assessment. The tools are leveraged in a multi-stakeholder workshop setting within the RIL, where participants respond to the question prompts in the tools by placing sticky notes into the respective squares and comparing results in order to generate discussion and reveal new opportunities.

Insights from effectuation theory and responsible innovation are incorporated into RIL activity through the leveraging of these tools, as both responsible innovation and effectuation theory were explicitly incorporated into their development. The Responsible Innovation Tool encourages users to reflect on innovation activity in responsible and effectuated terms (e.g. anticipating and including network partners, or pivoting to seize new opportunities for impact). The Responsible Impact Tool assists users in incorporating responsibility and effectuation into the development of project- or context-specific methods of impact assessment (e.g. anticipating opportunities for impact, reflecting on trade-offs in developing assessment methodologies).

Paper II develops the Circular Experimentation Workbench, a workshop process tool for engaging in circular business model experimentation (Figure 10). This tool was informed and iteratively developed via both quantitative and qualitative feedback received through test workshops as part of a design science research process. These results are summarized in Table 6 (quantitative) and Table 7 (qualitative). Note that for the sake of space, the qualitative results are presented in the form of ‘key

takeaways', where overlapping feedback was combined and represented in short form, rather than providing all of the qualitative feedback in its entirety. As a workshop process tool, the Workbench is comprised of a number of other individual tools, all of which are used in sequence as part of a broader workshop process which guides users through the development and testing of circular business model ideas. As with the Responsible Innovation Tool and Responsible Impact Tool, effectuation theory was intentionally incorporated into the tool's development. In this case, however, it was explicitly combined with Lean Startup methodology, an iterative approach to developing and testing business ideas which emphasizes rapid experimentation, quick learning, and regular pivoting in order to develop business models, products and services with a high probability of success in the market (Ries, 2011). The result is a unique tool which combines the advantages of effectuation thinking with the benefits of the Lean Startup approach.

Table 6. Results from tool evaluation, quantitative (Paper II).

	Workshop 1	**Workshop 2**	**Workshop 3**	**Overall assessment**
How easy was the workshop to follow? *(mean & standard deviation)*	4.15 (0.69)	4 (0.63)	4.17 (0.49)	**4.11**
How useful was the workshop for you? *(mean & standard deviation)*	4.23 (0.83)	4.5 (0.84)	4.33 (0.53)	**4.35**
Number of respondents and participants	13 (18 participants)	6 (13 participants)	7 (16 participants)	

Table 7. Results from tool evaluation, qualitative (Paper II).

Key takeaways	**Suggestions for improvement**	**Actions**
Provided useful new methods (e.g., "the effectuation theory and experiment design", "clear frameworks", "circularity deck")	Explanation: - Additional intro or guidance - Written step-by-step process	- Allocate sufficient time for explanation. - The final tool may include additional explanation text boxes to make it self-explanatory

Collaboration is fun and helpful (“co-creation is ultra great”, “connection and group work”, “always inspiring to hear other peoples stories”)	Participants: - Do this with a multidisciplinary team. - More people from the same sector.	- Organize future sessions with specific teams within companies and/ or take more time to select participants.
Lean aspects were appreciated (“use less resources to implement a circular business model”, “Simplicity and rapidity to develop ideas”, “Quick inspiration”)	Process: - More time / a little more time for the process. - Series of workshops for the same team.	- Extend the tool to a 2-2.5 hour session when the setting allows for it. - Incorporate the tool into long-term intrapreneurial innovation processes
Circularity aspects were helpful (“the circular deck”, “Circularity Deck and tools”, “circular deck and process”)	Preparation: - Specific circularity challenges to prepare in advance.	- When organizing sessions, pre-select challenges or ask companies to choose specific ones to deal with in the group

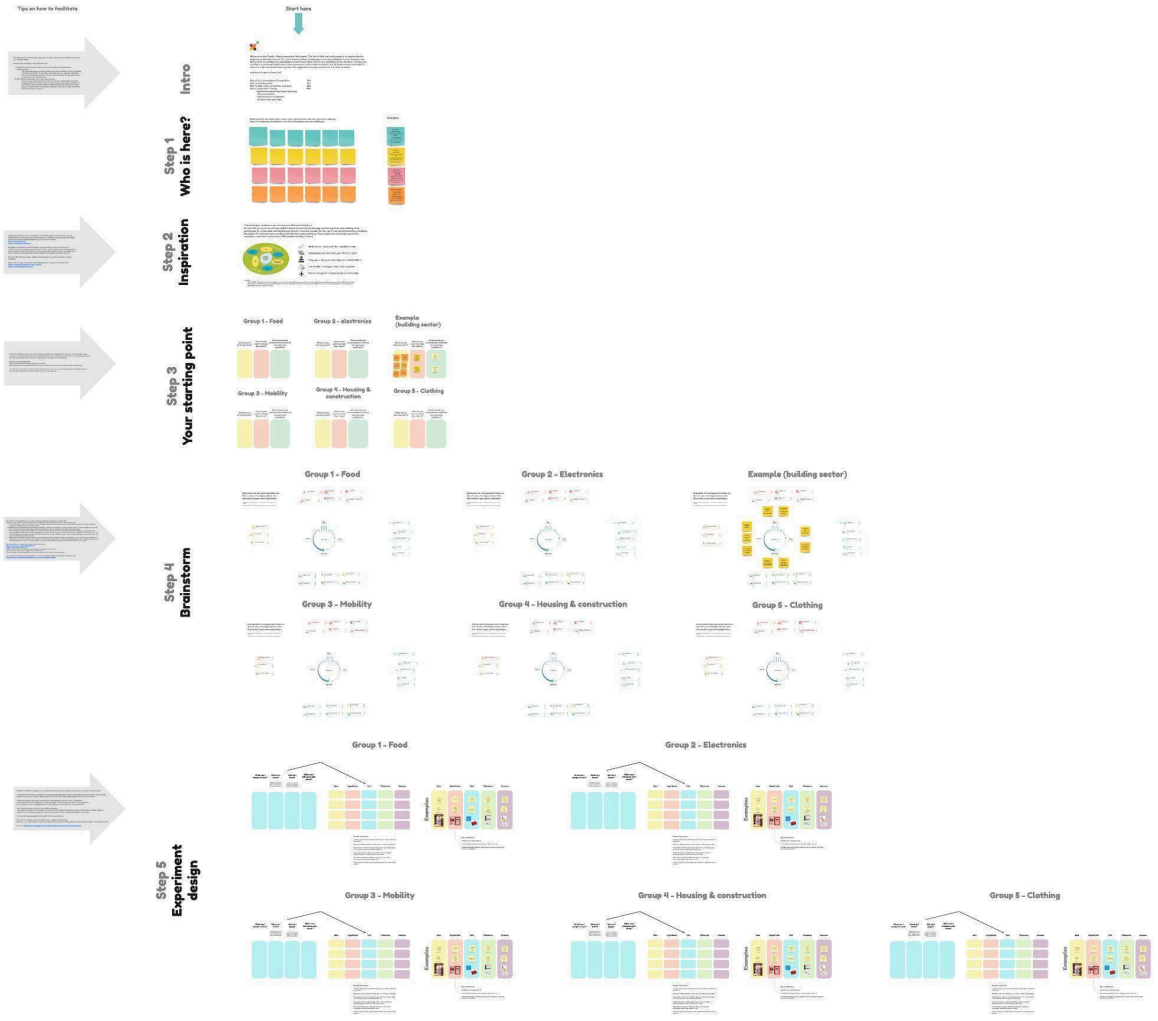

Figure 10. Zoomed-out view of Circular Experimentation Workbench. From Paper II. For a detailed zoomable view which can be copied to a Miro board, visit the Miroverse version at https://miro.com/miroverse/circular-experimentation-workbench/

Workshop participants begin by identifying themselves and the circular challenges they face. They're then briefly introduced to the Lean Startup methodology and the core concepts of effectuation theory, before being prompted to share what they find important, how they want to shape the future, and what influences their ambitions. They then ideate by incorporating the core circular economy principles of narrowing, slowing, closing, and regenerating resource loops into their initial prompts. This is facilitated with the inclusion of the Circularity Deck, a tool which provides concrete examples of these key circular economy principles in real-life business contexts (Konietzko et al., 2020b). These ideas are then recombined with key effectuation

principles (what can I afford to lose?, what do I know?, who do I know?, and what can I influence with whom?), mapped into testable hypotheses, and tested and measured following a Lean Startup process.

The development of the tool and conducting of the workshops described in Paper II further led to the development of three distinct propositions:

Proposition 1: Effectuation-focused questions (e.g. what workshop participants find important, how they want to shape the future, etc.) can help participants focus on where they can take action to have the most impact in the circular economy transition.

Proposition 2: Effectual logic supports and enriches the lean startup logic and methodology in a way which uniquely supports the development and execution of circular business model experiments.

Proposition 3: Innovators and entrepreneurs aiming to address the wicked challenges which characterize the transition toward a circular economy are well served by leveraging the Lean Startup methodology, as it can assist them in developing targeted circular business model experiments in order to begin addressing these challenges.

Paper IV develops Sustainable By Design, an organizational design tool which assists firms in identifying the cultural, strategic, and organizational barriers and drivers which can either hinder or facilitate the development of dynamic capabilities for sustainable business model innovation (Figure 11). As with Paper II and the Circular Experimentation Workbench, the Sustainable By Design tool was developed using a design science research method which involved soliciting both quantitative and qualitative feedback from participants through a series of workshops. These results are summarized in Table 8 (quantitative) and Table 9 (qualitative). As with Paper II, note that the qualitative results are presented in the form of summarized 'key takeaways' rather than in their entirety.

Table 8. Results from tool evaluation, quantitative (Paper IV).

	Workshop 1 (DSM)	**Workshop 2 (IKEA**	**Overall assessment**

		Retail (Ingka Group))	
How easy was the workshop to follow? *(mean & standard deviation)*	4.00 (0.89)	4.55 (0.69)	**4.35**
How useful was the workshop for you? *(mean & standard deviation)*	3.67 (0.52)	4.18 (0.60)	**4.00**
Number of respondents and participants	6 (8 participants)	11 (15 participants)	

Table 9. Results from tool evaluation, qualitative (Paper IV).

Key takeaways	**Suggestions for improvement**	**Actions**
Robust methodology helpful for organizational design "Key to follow a robust methodology and process to surface real issues"	Explain next steps and follow up procedure	Discuss potential tools and workshops to follow up and take action on barriers and drivers (e.g. roadmapping)
The culture gap "Gap between what [we] say and what [we] actually want…how might we close that gap?" "The concept of actualized culture, to put a sticker on the main things that keep us away from what we aim to do" "We struggle to assess feasibility to change because there is a gap between what we say / our ambition vs reality"	Some content overlap between barriers and drivers across Culture, Strategy and Operations	During facilitation, remind participants to focus on Barriers and Drivers in each breakout session in terms of either Culture, Strategy, or Operations, depending on session

Risk aversion “How can we develop the risk appetite?” “the organization seems to be quite risk avert (sic) (in some areas)” “How can we collaborate more, allow more risks?”	More pre-read and prep material would help align participants beforehand	Consider sending out a survey pre-workshop to assess participant knowledge base and assign pre-reads as necessary
Differing views across business areas and silos “We have different perceptions on our…reality, depending on where we are working” “there is some heterogeneity across business groups and different ways to see the actual status” “bringing together of the different perspectives from the 3 breakout groups was hard”	More time for discussion in plenary sessions	Where possible, consider extending workshop from half day to three-quarters or full day to allow for more discussion in plenary

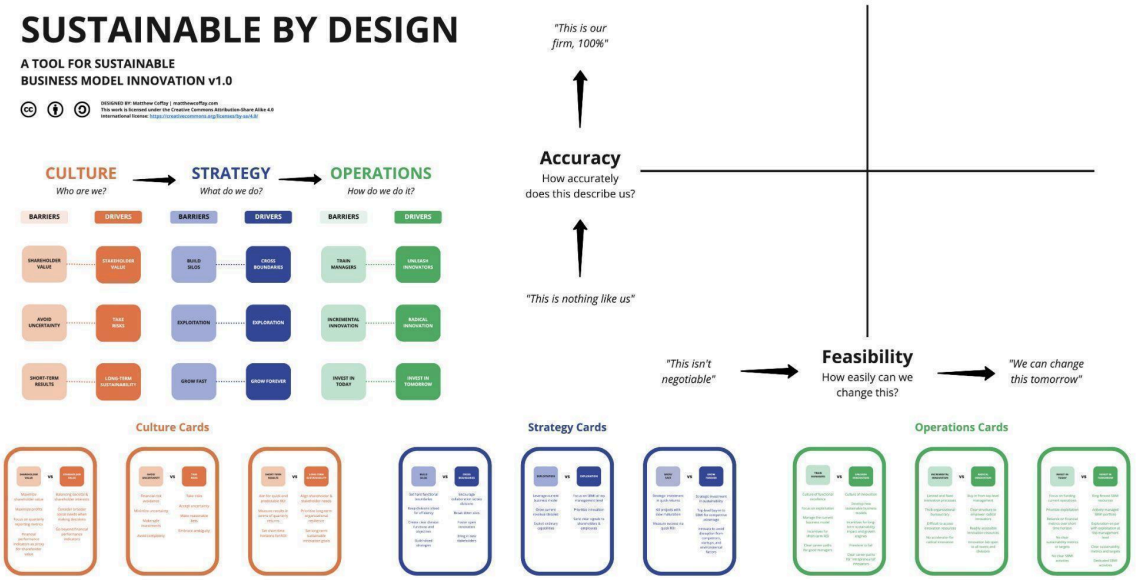

Figure 11. Zoomed-out view of the Sustainable By Design tool. From Paper IV. For a zoomable view, visit https://miro.com/app/board/uXjVOu7qLgQ=/.

Again designed for a workshop setting, the tool consists of several parts: a map of barriers and drivers; nine cards which describe these barriers and drivers; and a design grid for mapping the barriers and drivers. Workshop participants map the barriers and drivers according to their accuracy (how accurately they describe the organization) and feasibility to change (how easy it would be to implement changes which might mitigate a given barrier or boost a given driver). At the end of the workshop process, those barriers in the top-right quadrant (highly descriptive of the organization, feasible to mitigate) and those drivers in the bottom-right quadrant (not descriptive of the organization, feasible to boost) of the grid are identified as those barriers and drivers which could most readily be acted upon in order to better drive SBMI within the organization.

In addition to the tool itself, the process of designing and testing the tool in collaboration with practitioners in Paper IV led to the development of three distinct lessons:

Lesson 1: The process of mapping organizational barriers and drivers of SBMI using a concrete and stepwise tool process assists firms in identifying sometimes conflicting understandings and visions of the organization present in different business areas and functions.

Lesson 2: When it comes to sustainability, a ‘culture gap’ may exist even in companies with high sustainability ambitions, wherein top management’s ideas about a sustainability-focused company culture do not necessarily align with the lived experience of contributors further down in the organizational hierarchy.

Lesson 3: Given the complexity of organizational design, particularly when it comes to addressing sustainability challenges, it is beneficial to follow a structured process such as the one facilitated by the Sustainable By Design tool in order to deliver actionable outcomes.

4.4. Discussion

This section first discusses and connects the findings from the individual research articles within the broader context of the dissertation. It then concludes by answers the research questions posed in the articles, as well as the overarching research question of the dissertation.

4.4.1. Connections between organizational design, dynamic capabilities, and SBMI

In addressing the design-implementation gap of SBMI (Geissdoerfer et al., 2018; Baldassarre et al., 2020), the dissertation has sought to develop both practical tools and insights for managers while also advancing theory at the intersection of organizational design, dynamic capabilities, and SBMI. Bocken & Geradts (2020) identified thirteen pairs of organizational barriers and drivers at the institutional, strategic, and operational level which either hinder or boost a firm's ability to develop the dynamic capabilities needed for successful SBMI. Following from the case study conducted in Paper III, we added to the emergent body of literature in this area by identifying four new organizational barriers and drivers: cultural ambiguity (cultural barrier), collaborative challenges (strategic barriers), cognitive challenges (strategic barrier), and public-private collaboration (strategic driver). Bocken & Geradts (2020) define 'institutional' as the "well-established rules, norms, and beliefs that describe the reality for the organization and guide their actions accordingly" (Bocken & Geradts, 2020, p. 6; Hoffmann, 1999). In Paper III and Paper IV, we therefore reframe 'institutional' as 'cultural' barriers and drivers, drawing on the literature on company culture which describes organizational culture as those characteristic organizational norms which guide behavior. This renders results more relevant for managers by simplifying terms and using language more familiar to them (Teece, 1996; Fiol, 1991). Reframing 'institutional' as 'cultural' also better connects the discussion in Papers III and IV with Teece (2018), Teece (2023), and Leih et al. (2015), which mention firm-level 'cultural' (not 'institutional') considerations in their discussion of the interplay between organizational design, dynamic capabilities, and business model innovation.

We found that firms in the case study placed excessive focus on fixed resource planning and exploitation of their existing business models. These barriers caused

firms to struggle with developing and leveraging sensing- and seizing-type dynamic capabilities for SBMI. Challenges relative to cognition (understanding the business model concept more generally, and specifically conceptualizing current activity in business model terms) as well as effective collaboration (data sharing, IP issues) impeded the development of seizing capabilities especially. The existence of various organizational drivers such as valuing business sustainability, collaborative innovation, public-private collaboration, people capability development, and patient investments counter-acted and mitigated the existence of these barriers to some extent.

We noted that cultural ambiguity (a newly identified cultural barrier) within some organizations in the case study, combined with the confounding factor of a supposed 'culture of innovation' within some firms, caused firms to struggle with transformation-type dynamic capabilities. We refer to 'culture of innovation' as a confounding factor because although some firms self-identified as having a distinctly innovative company culture, our analysis of interviews and supporting data revealed that this was often times incremental innovation (including especially incremental technology-focused R&D) rather than radical business model-type innovation. Without an understanding and awareness of more radical business model innovation as distinct from more incremental and/or purely technologically-focused forms of innovation, firms can struggle to sense and seize new opportunities for business model innovation, or engage in the cultural transformation necessary to deliver on their sustainability goals. Similarly, we found many firms self-presenting with 'sustainability as a core value', although this turned out to be a confounding factor in the same sense as the 'culture of innovation' self-assessment. This was because the supposed cultural value of sustainability was itself incremental rather than especially strong or radical in nature, and subsequently understood strategically in incremental rather than more radical terms. This in turn would lead to incremental adjustments to the existing business model rather than radical innovation for sustainability. Teece (2018) identifies this kind of incremental adjustment as grounded in the second-order microfoundations of dynamic capabilities, i.e. adjusting and reconfiguring ordinary capabilities for exploiting the current business model. This is however distinct from the higher order sensing, seizing, and transforming capabilities

involved in developing and pursuing new business model opportunities. Firms exhibiting these barriers and confounding factors can therefore find themselves stuck in the design-implementation gap of SBMI, even as they self-assess as having innovative and sustainability-focused cultures and strategies.

Indeed, I found a lack of both a clear and shared understanding of company culture broadly — as well as the capacity for cultural transformation for sustainability and innovation specifically — to be a challenge for firms in both the Paper III case study as well as an issue which arose during the assessment portion of the design science process in Paper IV. As noted in Paper IV, there can be wide variation amongst individuals across different organizational areas and functions when it comes to assessment of organizational barriers and drivers. Contributors within one group function (e.g. sustainability) could have a very different perception of the presence of certain organizational barriers to SBMI when compared to a contributor in another function (e.g. finance). We observed this in particular in plenary workshop sessions, where participants from different group functions and business areas would present very different assessments of cultural (and strategic and operational) barriers and drivers within the organization.

Particularly in the case of company culture, we found this showing up as what we term the 'culture gap' of sustainability and innovation. In Paper IV, we heard from workshop participants that the cultural values espoused by top management around e.g. sustainability did not always align with the lived experience of contributors in key parts of the organization, such as the sustainability function. While there has been substantial research around addressing the design-implementation gap through better ideation and testing of sustainable business models (e.g. Baldassarre et al., 2020; Geissdoerfer et al., 2018), we identified an opportunity to address this problem at a higher level and more preliminary stage through assessing the current cultural status of the organization and taking action as needed to drive cultural transformation. Teece (1996) argues that while the "vision held by top management and by individuals lower down in the organization may not be congruent," it is "the latter…which define an organization's culture" (Teece, 1996, p. 206; O'Reilly, 1989). We observed that the idealized version of a sustainability-focused culture at the top

levels of an organization do not always manifest as intended at lower organizational levels, and that this discrepancy must be addressed in order to develop the kind of day-to-day culture which can effectively drive the strategy and operations needed for effective SBMI.

This is, however, easier said than done — not just because effecting cultural change is complex, as it tackles the intersection of behavior, identity, and deeply held values (Fiol, 1991), but also in light of a theoretical insight which emerged from the combined observations in Paper III and Paper IV. Teece (2018) notes that the "realigning of culture" actually partly constitutes transformation-type dynamic capabilities (p. 44). Based on combined observations from Paper III and Paper IV, I observed that in light of Teece's point, this creates a chicken-and-egg problem for firms. On the one hand, the presence of various cultural organizational barriers and/or the lack of cultural organizational drivers can limit a firms' ability to develop the dynamic capabilities needed for effective SBMI. But at the same time, cultural transformation is itself a transformation-type capability. This explains why organizations might struggle so much with cultural issues, including the ability to engage in the kind of cultural transformation needed for SBMI: companies must on the one hand reinvent their culture in order to pave the way for the development of the right dynamic capabilities for SBMI, but this cultural transformation itself is a dynamic capability which firms may not possess.

An important consideration here is a finding in Bocken & Geradts (2020), as further confirmed in Paper III and Paper IV: that company culture (institutional factors per Bocken & Geradts) is the foundation which drives strategy and operations. Indeed, an important conclusion of Paper III was the extent to which culture serves as as the broader space within which dynamic capabilities and SBMI actually play out. Building on the simplified schema presented in Teece (2018) — where strategy, dynamic capabilities and business model innovation interact, but without adequate attention paid to the role of culture — and Bocken & Geradts (2020) — where culture is only addressed in terms of specific institutional barriers and drivers — we developed a new framework for thinking about the interaction between these elements (Figure 12). Specifically, the existence of barriers at the cultural level tends

to lead to barriers at the strategic level, which in turn result in operational barriers. Similarly, organizational drivers at the level of culture will tend to encourage the development of strategic drivers, which in turn contribute to organizational drivers. Further, each of these three levels of organizational design individually contribute to the development of sensing, seizing, and transforming-type dynamic capabilities (Bocken & Geradts, 2020; Figure 12). It therefore becomes clear just how important company culture is in this context, as the presence of substantial cultural barriers will make it difficult to mitigate strategic and operational barriers, while the absence of cultural drivers will create challenges for boosting strategic and operational drivers. All of this reinforces how problematic it can be for companies that find themselves stuck in this chicken-and-egg scenario of a culture which does not facilitate the development of dynamic capabilities for sustainable innovation, including transformation-type capabilities, which themselves are important for enabling cultural transformation. Based on this theoretical model, it is for example not advisable (and perhaps not possible) to implement strategic and/or operational changes (e.g. boost strategic drivers, mitigate operational barriers) within an organization without simultaneously addressing cultural barriers and drivers and engaging in cultural transformation. But given that the ability to do this kind of cultural work is a dynamic capability which firms may not already possess, one can quickly see what a heavy lift this becomes for organizations with limited resources. It is precisely for this reason that tools such as the one developed in Paper IV are so valuable in these contexts, as they give organizations additional leverage for this lift of cultural transformation and pave the way for bridging the SBMI design-implementation gap (Geissdoerfer et al., 2018; Baldassarre et al., 2020).

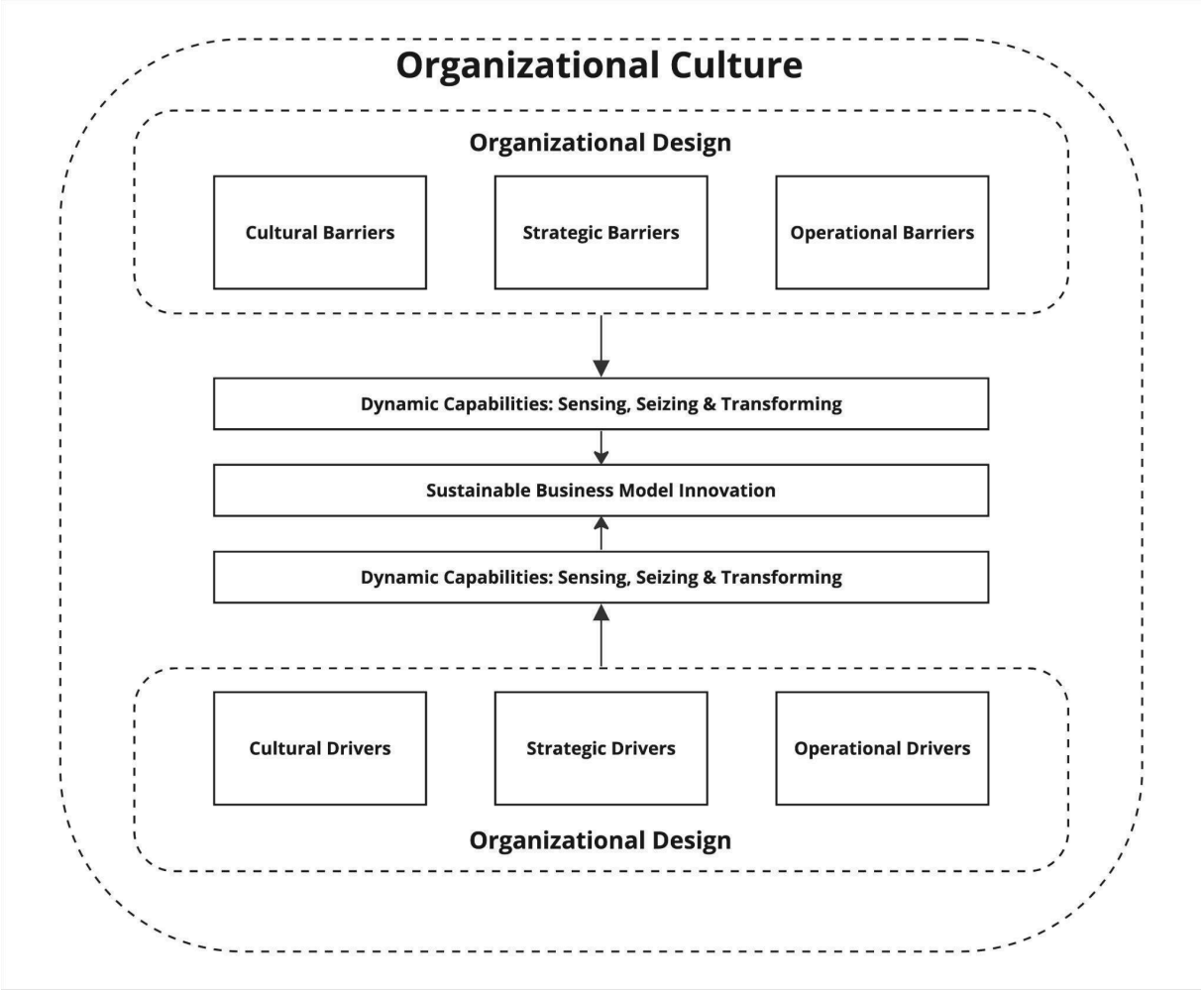

Figure 12. Framework for organizational culture, organizational design, dynamic capabilities, and SBMI. From Paper III.

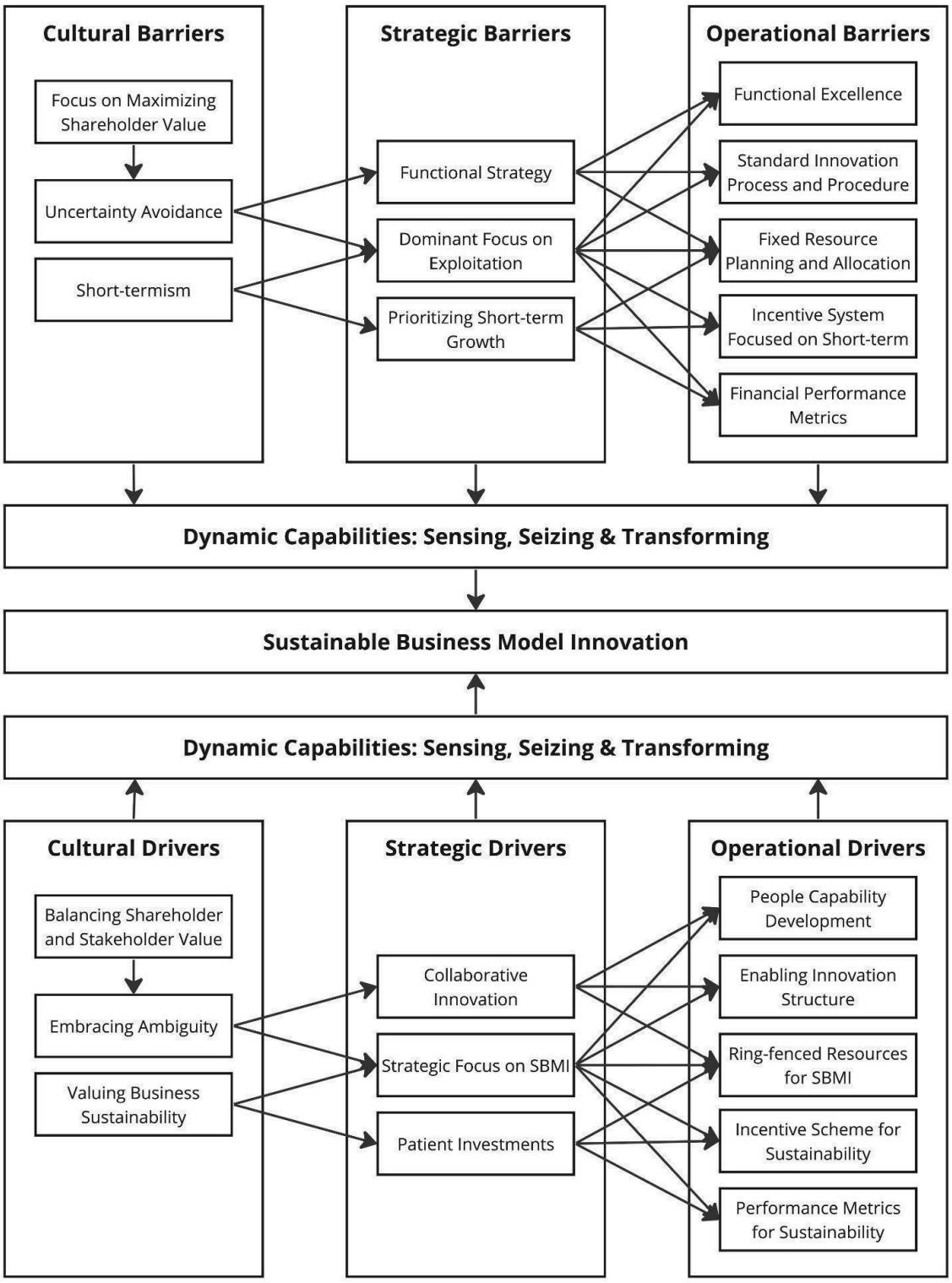

Figure 13. Relationship between cultural, strategic, and operational drivers and the development of dynamic capabilities for SBMI. Adapted from Bocken & Geradts (2020).

Over the past two decades, a separate stream of literature has slowly emerged around the intersection of company culture and sustainability, though this literature is still in its infancy, as described in Section 2.6. Linnenluecke & Griffiths (2010) consider how consensus between leaders and contributors in an organization around "environmental values and beliefs" might trickle down from top management to lower tiers within an organizational hierarchy, but subsequently note that empirical studies have shown this can often be more symbolic than real, something confirmed in the discussion of the culture gap in Papers III and IV (Linnenluecke & Griffiths, 2010, p. 363; Harris & Crane, 2002; Howard-Grenville, 2006; Welford, 1995; Hoffmann, 1993; Dodge, 1997). As opposed to this trickle down view where sustainability culture becomes homogeneously present across the organization — termed the 'integration perspective' — Linnenluecke & Griffiths (2010) describe a so-called 'differentiation perspective' also present in the literature and confirmed by empirical studies, where particular group functions or divisions within an organization each display their own particular subcultures (Martin, 2002; Zammuto, 2005; Hofstede, 1998; Schein, 1996; van Maanen & Barley, 1984). These subcultures may then cohere with the broader supposed 'culture' of the organization to greater or lesser degrees, including in terms of shared values and beliefs around sustainability (Linnenluecke & Griffiths, 2010; Howard-Grenville, 2006).

It is precisely these sorts of subcultures which were observed in Paper IV, especially in the workshop with Ingka Group (IKEA Retail). Workshop participants came from a range of group functions, including sustainability, circularity, strategy, risk management, and finance, with both managers and contributors represented. Linnenluecke & Griffiths (2010) argue that it is through an understanding of the different subcultures within an organization that a company can develop "a range of more sophisticated and tailored programs for the successful adoption of sustainability practices," including the implementation of customized change management approaches based on function or division (Linnenluecke & Griffiths, 2010, p. 363; Linnenluecke et al., 2007).

While this is a useful insight, it is not clear from the literature on culture and sustainability exactly how one might go about this process. Paper IV makes a

substantial contribution in this area, as the Sustainable By Design tool can be utilized to provide a differentiated assessment of organizational barriers and drivers — not only cultural, but also strategic and operational, both of which can be understood as emerging from the presence or absence of the various cultural barriers and drivers — allowing managers or consultants to determine what sorts of initiatives might be most appropriate to create a culture of sustainability within a particular group function or division. For example, both the innovation and finance functions may be misaligned with top-level organizational commitments to a culture of sustainability, but the cultural (and strategic and operational) barriers described in Papers III and IV may present in different ways and to different extents in each function. Further insight can be gained from assessing which strategic and operational barriers and drivers are present within each function's subculture, as well as from hearing how workshop participants perceive the reality of the broader organization's actual culture, as opposed to that which is nominally represented in communication from top management (Teece, 1996). Workshop participants in Paper IV commented on precisely this, noting that "we have different perceptions on our…reality, depending on where we are working," and "there is some heterogeneity across business groups and different ways to see the actual status." It is through this kind of granular engagement across the subcultures which constitute various group functions and divisions that broader cultural alignment around sustainability can be achieved through targeted interventions which address the specific cultural, strategic, and operational barriers and drivers to SBMI as they present in each function or division.

In addition to these key findings related to organizational culture, collaboration showed up repeatedly as an important theme in the Paper III case study, as well as in the workshops conducted and tools developed in Paper II and Paper IV. Given the context of the Paper III case study — that is, a public-private innovation project involving many stakeholders from firms, universities, research institutions, and government agencies — it is perhaps not surprising that collaboration was a key theme. However, the insights derived from the case are generalizable in other less obviously collaboration-dependent contexts. Snihur & Bocken (2022) note that since sustainability issues are wicked and require the input of many actors within a broader innovation ecosystem, collaboration "beyond the remit of a single firm" is especially

important for engaging in SBMI (p. 4). This same observation was made by Unilever's CEO Paul Polman in 2012: "The issues we face are so big and the targets are so challenging that we cannot do it alone, so there is a certain humility and a recognition that we need to invite other people in" (Confino, 2012; quoted in Ferraro et al, 2015). George et al. (2023) also highlight the important of collaboration for addressing the grand challenges posed by sustainability issues, particularly at an organizational design level.

Collaborative innovation and public-private collaboration were especially strong strategic organizational drivers in the case context, and we would argue these drivers are important not just for aquaculture but for any primary industry, e.g. agriculture or forestry. This is because in addition to the considerations above around the collaborative nature of sustainability issues in general, primary industries involve complex value chains that connect both private and public actors. License to operate — both social license as well as the license provided by government regulators — is key in primary industry contexts, and engagement with a wide range of stakeholders is therefore essential to tackling sustainability issues. The work required to develop new and sustainable value chains in these contexts also requires collaborative innovation directly between firms, as sustainable business model innovation in one firm will both be dependent upon and have ripple effects which impact the business models of other firms in the value chain. Effective collaboration for innovation allows firms to sense and seize new opportunities. Meanwhile, public-private collaboration in the form of increased engagement with government stakeholders and policymakers can aid firms in complying with emergent regulatory requirements while de-risking new business models.

While these observations related to collaboration are about ecosystem-level interactions between stakeholders (e.g. between firms, or between firms and government agencies), Paper IV highlighted the importance of collaboration between individual actors across organizational silos within a single firm. As discussed above, it was through coming together in a cross-functional workshop context that individual participants were able to reveal different perceptions, understandings, and capabilities to tackle various organizational barriers and drivers for SBMI. Engaging

with leaders or contributors in a single organizational function or business area would likely not have revealed these same insights, highlighting the value of bringing together different actors in different parts of an organization when attempting to map organizational barriers and drivers.

Further, the design science process in Paper II revealed the value of collaboration between heterogenous actors for circular business model innovation contexts. Participants with different backgrounds noted that collaboration was helpful, writing in their assessments that "co-creation is ultra great" and that it's "always inspiring to hear other people's stories." Some participants even suggested mandating that the workshop involve a "multidisciplinary team" in order to accentuate these benefits. Seeking out effective collaborators is in fact key in circular business models in practice (Kraaijenhagen et al., 2016). This makes intuitive sense, given that the circular economy by its very nature implies interdependencies between actors in order to narrow, slow, close, and regenerate resource loops. More precisely, however, Paper II determined that a specific focus on collaboration in the workshop context — particularly the collaborative aspects of effectuation theory such as the 'crazy quilt' principle, wherein entrepreneurs go from one stakeholder to the next, gaining buy-in and commitments from familiar stakeholders in order to further expand their possibilities and connect with new ones — could help innovators look beyond their existing organization for the resources and collaborators they need to realize a circular business model experiment (and, eventually, pilot and scale a new circular business model). This is especially salient when connecting with stakeholders who can act on a particular circular economy challenge.

4.4.2. Effectuation in sustainability and design science research

As discussed in Section 1.2, one of the key reasons that companies struggle to bridge the design-implementation gap of SBMI is a lack of good tools (Geissdoerfer et al., 2018). A key focus us the doctoral project was developing practical tools that companies could use, with the resulting tools described above in Section 4.3. Here, I would like to briefly discuss the connections between effectuation theory and some of the tools specifically, as well as the design science research process more generally.

Paper I explored the relevance of effectuation for thinking about sustainability impacts and sustainability-focused innovation. Effectuation theory was key in developing the Responsible Innovation Tool and Responsible Impact Tool (see Section 4.3). More broadly, however, we found that effectuation thinking can reveal unique challenges and ways of approaching sustainability impacts in general. When thinking in effectuated terms, sustainability impact forecasting and assessment is not just a question of choosing metrics and methods for assessment of a new venture. Instead, the impact forecasting and assessment process becomes an ongoing evaluative activity, wherein changes in business model, technology, regulatory frameworks, and sustainability targets must necessarily be taken into consideration as part of a routine reassessment of impact metrics and methods. Rather than considering both sustainable innovation and the accompanying forecasting and assessment processes as planned and linear — following causal-type innovation thinking, e.g. choosing and following a recipe to prepare a dish (see Section 2.3)— these processes are often effectuated, taking into account available means and shifting circumstances and acting accordingly (e.g. doing what you can with the circumstances that present themselves, while simultaneously acknowledging your role in shaping the future). In particular, new ventures (including intrapreneurial ones in a corporate innovation setting) are not necessarily tied to predetermined impacts opportunities, but rather encouraged to evaluate the potential to create new impacts in an effectuated way as the innovation process unfolds.

Effectuation theory was also specifically incorporated into the development of the Circular Experimentation Workbench, the workshop process tool presented in Paper II. Workshop participants were keen to learn about and leverage effectuation-type thinking in the workshops we conducted, and we found that combining effectuation theory with more conventional approaches to business model experimentation (in this case, Lean Startup) was highly effective in facilitating experimentation for circular business models in particular.

More broadly, effectuation showed up as an ongoing theme in the design science research process. Identifying potential companies and participants for workshops was largely an exercise in effectuation. Both in the case of Paper II and Paper IV, we

approached the Evaluation step of the design science research process by reaching out to existing professional networks in a crazy quilty-type fashion (Sarasvathy, 2001), organizing workshop sessions with the assistance of key stakeholders. Executing these workshops effectively, particularly in the case of the in-person IKEA Retail workshop, was dependent on the cooperation and contribution of key stakeholders within the organization. These stakeholders had to make a strong case for why valuable resources should be directed toward engaging in our research project, particularly considering the valuable time commitment coming from some of the organization's senior participants. Had we taken a more causal approach to this part of the design science process — for example, by identifying target companies ahead of time and only pursuing those companies in order to conduct the Evaluation portion of the tool development process — the evaluation step would have likely been substantially more protracted, and may have even been impossible to complete within the timeline afforded by the doctoral period.

4.4.3. Answering the research questions

In light of the results and discussion presented above, this section offers concise answers to each of the research questions presented in the articles which comprise the dissertation, followed by a response to the overarching research question behind the dissertation as a whole. This research question is approached through the development of four peer-reviewed articles, each of which addresses related but distinct research questions which are subsumed under the primary research question and which attempt to cover the various gaps identified above. These research questions are as follows:

RQ1: How can the concepts of Responsible Research & Innovation (RRI) and effectuation inform firm-level innovation processes, as well as the forecasting and assessment of sustainability impacts?

Firms seeking to incorporate responsible innovation into their innovation activity can take part in a Responsible Innovation Lab (RIL), a novel concept developed in Paper I which combines responsible innovation and effectuation theory with the living lab concept. Through the RIL, both effectuation theory and responsible innovation can

inform innovation activity and impact forecasting and assessment. In the RIL context, both sustainability-focused innovation activity and the development and execution of impact forecasting and assessment methods can draw on the responsible innovation notions of anticipation, inclusion, reflexivity, and responsiveness, while simultaneously leveraging effectuated thinking to co-create new sustainable ventures and impact methodologies with other stakeholders.

RQ2: To what extent can Lean Startup and Effectual thinking be combined to support the circular business model innovation process?

Paper II found that Lean Startup and effectuation can be fruitfully combined to support circular business model experimentation. Leveraging these two approaches to innovation resulted in the development of the Circular Experimentation Workbench, a tool which enables practitioners to develop circular business model experiments in a lean and effectuated way. We further found that effectuated thinking can help circular innovators identify where they can have the most impact in the circular economic transition. Effectual logic can also support and enrich the lean logic needed for circular business model experimentation. At the same time, lean startup provides much needed structure to the circular business model experimentation process, a structure which might be missing with a pure effectuation approach.

RQ3: How do organizational design, dynamic capabilities, and sustainable business model innovation interact in the context of an emergent low-carbon offshore aquaculture value chain which places new organizational and capability demands on firms?

Paper III found that both a number of previously identified organizational barriers and drivers (Bocken & Geradts, 2020) at the cultural, strategic, and operational levels, as well as newly identified organizational barriers and drivers were present in the case context we examined. These barriers and drivers impede firms' ability to develop the dynamic capabilities needed for SBMI. Further, the cultural barriers and drivers reinforce the strategic ones, which in turn reinforce the operational ones. Cultural transformation is particularly challenging in this context, and engaging in

cultural transformation can require considerable effort on the part of firms due to a lack of existing dynamic capabilities to facilitate this transformation. However, prioritizing a culture shift could have a ripple effect on mitigating barriers and boosting drivers for SBMI at the strategic and organizational levels, leading to the development of sensing, seizing, and transforming capabilities.

RQ4: How can firms address organizational design issues in order to develop the dynamic capabilities necessary for sustainable business model innovation?

Paper IV developed the Sustainable By Design tool, which can aid firms in developing the dynamic capabilities needed for SBMI. The tool assists firm in assessing organizational barriers and drivers which must be mitigated or boosted in order to facilitate the development of the necessary dynamic capabilities for SBMI. Further, we determined that a tool is particularly useful in this context as it helps structure the assessment process and reveal differing perceptions across organizational functions and business areas. This is especially important for addressing issues around cultural transformation, which can be difficult to address as described in Paper III and discussed in Section 4.4.1.

RQ: How can firms overcome the design-implementation gap of sustainable business model innovation?

The central research question of the dissertation is answered through a synthesis of insights from the component articles.

Firms aiming to succeed with SBMI must bridge the design-implementation gap of SBMI, avoiding the pitfalls identified in Figure XX (see Section 1.3.). To do this, they can embrace effectuation and responsible innovation, including through participation in structured forums such as a Responsible Innovation Lab. They can utilize key tools for responsible, circular, and sustainable business model innovation, including the Responsible Innovation Tool, Responsible Impact Tool (Paper I), Circular Experimentation Workbench (Paper II), and Sustainable By Design (Paper IV). Further, they can engage in honest organizational self-assessment, aiming to tackle key organizational barriers and drivers at the levels of culture, strategy, and operations. Doing so will aid them in developing the dynamic capabilities needed for

effective SBMI. Lastly, firms would be well served by participating in collaborative public-private innovation projects which aim to advance the green transition (Paper III) and embracing the importance of collaboration, both across functions (Paper IV) and across organizational boundaries (Paper II, Paper III).

5. Contributions and concluding remarks

This last chapter first provides an overview of the dissertation's contributions to practice, theory, and methods. It then considers some of the limitations of the research. Finally, it offers some concluding remarks.

5.1. Contributions to practice

Central to my approach throughout the dissertation was the leveraging of design science research, as well as a case study approach with elements of action research. Contributions to these methodological approaches are discussed further in Section 5.3, Contributions to Method. Worth mentioning here, however, is the role that philosophical pragmatism has played in the orientation of the dissertation, as well as in my approach to situating and reflecting upon the contributions to practice and theory made by my research. As discussed in Section 3.1, a pragmatist epistemology is in some ways as much a theory of inquiry as it is a theory of knowledge, and this process of inquiry centers around experimentation. By engaging in experimentative processes aimed at solving real-world problems — e.g. through design science research — my work has attempted to help bridge the design-implementation gap of SBMI not just from an academic research and theory-building perspective, but from a practitioner-centered one.

Management scholars have long discussed a so-called 'research-relevance gap' in the literature, expressing dismay at the disconnection between business school research on the one hand and practice on the other (see for example Tranfield & Starkey, 1998; Starkey & Madan, 2001; Kieser & Leiner, 2009). At the same time, there is an increasing need for business school researchers to contribute more directly to practice in light of the urgency presented various sustainability challenges (Coffay & Tveterås, 2023). This implies a need for new incentives, particularly for early career researchers: for example, researchers could be better incentivized to actively engage in public-private innovation projects where outcomes are not measured purely in terms of publication output, but also by the quality of real-world innovation outcomes. This kind of practice-oriented engagement is in fact in alignment with the overall mission of the doctoral program within which my doctoral research was

completed, which seeks to encourage doctoral candidates to not just study innovation, but also to 'do' innovation (see Section 3.5). I would argue that research grounded in epistemological pragmatism which seeks to make a contribution to practice can enrich the doctoral experience generally, but perhaps more importantly can allow candidates in such a program to deliver on this mission of 'doing innovation.'

As already mentioned, a primary motivation for the research was to develop tools and insights with direct relevance for practitioners. In this way, the dissertation has contributed to closing the design-implementation gap of SBMI. At the same time, the dissertation has attempted to bridge and further develop various bodies of literature in order to both build theory and derive insights relevant for managers — both of which also contribute to bridging the aforementioned gap. Specifically, the dissertation closes this gap and advances practice in four central ways. First, it bridges effectuation theory with responsible innovation, sustainability impacts, circular business models, and Lean Startup, thereby augmenting our understanding of how these bodies of literature connect while also contributing insights for practice (e.g. the value of combining Lean Startup thinking with effectuation thinking for driving circular outcomes). Second, it provides generalizable insights related to organizational design, dynamic capabilities, and SBMI, which in addition to advancing the emergent body of theory examining the interplay between these concepts also aides managers in organizational assessment and design for SBMI. Third, the research develops tools for responsible innovation, circular business model experimentation, and organizational design for SBMI. Finally, it offers unique industry-specific insights related to offshore aquaculture in Norway.

As discussed in Section 5.2, the dissertation engages substantially with effectuation theory. The effectuation theory literature has long been relevant for those working in entrepreneurial contexts, but up until now there was a lack of research examining how effectuation theory could connect with responsible innovation, sustainability impacts, circular business models, or Lean Startup. Paper I bridged part of this gap, showing how managers could use effectuation theory in combination with the four principles of responsible innovation (anticipation, inclusion, reflexivity, and

responsiveness) to engage in sustainable innovation activities and develop context-specific approaches to forecasting and assessing sustainability impacts. It developed two tools, the Responsible Innovation Tool and Responsible Impact Tool, which managers can leverage in complex multi-stakeholder contexts (including in collaboration with researchers) to aid in sense-making and the development of appropriate impact assessment methodologies. Paper II proceeded to connect effectuation theory with Lean Startup in the context of circular business model experimentation. In exploring the complementary insights offered by these two different approaches to innovation, the paper developed the Circular Experimentation Workbench. This tool aids practitioners in developing circular business models by designing and testing new circular business ideas in a lean and effectuated way. The combination of these two methods provides practitioners with advantages which neither would offer on its own, with the whole approach being greater than the sum of the parts. Practitioners can conduct quick, lean experiments while ensuring that they focus on areas where they can effect the most change and develop truly circular business model ideas.

Papers III and IV develop generalizable insights (i.e. not specific to the case context of Paper III or the specific companies involved in testing the tool developed in Paper IV) for practitioners related to organizational design, dynamic capabilities, and SBMI. In addition to insights previously advanced in Bocken & Geradts (2020), Paper III identified new organizational barriers and drivers which firms should consider if they want to develop the dynamic capabilities needed for SBMI, including cultural ambiguity (cultural barrier), collaborative challenges (strategic barriers), cognitive challenges (strategic barrier), and public-private collaboration (strategic driver). Importantly, companies aiming to develop dynamic capabilities for SBMI cannot simply intervene at the operational level, as this is impacted by barriers and drivers at the strategic level, which in turn is undergirded by cultural barriers and drivers. Companies must therefore take action at the fundamental level of company culture in order to effect strategic and operational changes, with all three organizational levels working together to generate dynamic capabilities for SBMI. This is not without its challenges, however, as both Paper III and Paper IV point to a culture gap around sustainability in the firms we studied. Many of the companies in Paper III lacked a

strong culture for more radical sustainability: while they see sustainability as central to who they are, deeper analysis revealed that this sustainability is sometimes more incremental, and it is unclear that this level of commitment will be adequate for developing the dynamic capabilities needed for the kind of radical SBMI which can propel companies to reach and exceed e.g. their 2030 emissions targets and other sustainability goals. Paper IV meanwhile further highlighted the presence of a culture gap around sustainability: while top management believe sustainability is embedded as a core value within the organization, contributors throughout the company (including those working in sustainability) may feel that there is inadequate commitment and buy-in from the top to drive radical transformation for sustainability. Companies must tackle these cultural challenges head on if they want to succeed with SBMI. In order to do so, they will need to pay heed to the fact that cultural transformation around sustainability is particularly difficult in light of the theoretical insight discussed in Sections 4.4.1 and 5.2: that according to Teece (2018), cultural realignment is a transformation-type dynamic capability, the development of which is itself impeded by the presence of cultural barriers and/or lack of cultural drivers. This underscores the importance of using the right tools to address the culture gap, such as the one developed in Paper IV. As discussed in Section 4.4.1, effectively overcoming this challenge may involve taking a differentiated approach which acknowledges the presence of different subcultures within an organization, and of differences between the experience of contributors within these subcultures and the supposed overarching norms espoused by top management (Teece, 1996; Linnenluecke & Griffiths, 2010). Leveraging a tool like Sustainable By Design can allow managers to conduct an honest assessment of subcultures and different experiences of company culture across group functions and divisions, and develop tailored interventions based on how the various cultural, strategic, and organizational barriers and drivers present in these different areas of the organization.

Indeed, the dissertation has developed four tools which researchers and practitioners can use to overcome the design-implementation gap. Paper I develops the Responsible Innovation Tool and Responsible Impact Tool, helping researchers and practitioners engage in responsible innovation activity and develop relevant approaches to impact forecasting and assessment in multi-stakeholder contexts.

Paper II develops the Circular Experimentation Workbench, a workshop process tool which allows practitioners to develop, test, assess, and pilot circular business model ideas while leveraging insights from effectuation theory and Lean Startup. Paper IV develops Sustainable By Design, a tool which aids companies in performing an organizational assessment to identify barriers and drivers at the level of culture, strategy, and operations. Acting to mitigate barriers and boost drivers can then pave the way for developing the dynamic capabilities needed for effective SBMI.

Finally, in addition to the generalizable insights developed around organizational design, Paper III contributes to practice by providing industry-specific insights related to offshore aquaculture in Norway. These insights can prove valuable for managers attempting to overcome the design-implementation gap and succeed with SBMI in this particular industry context. We observed that conventional thinking about business model innovation pays little attention to the role of social license in lieu of a focus on e.g. key partnerships with suppliers (Osterwalder & Pigneur, 2010). But in primary industries like aquaculture, especially in the context of the substantial risk and uncertainty associated with the development of offshore aquaculture, a sustainable business model will be one which considers social license as a key resource, a range of stakeholders as key partners (including non-private actors like local communities, NGOs, regulatory agencies, government stakeholders, and researchers), and obtaining social license through the active development of these partnerships as an essential key activity. Further, companies must aim for SBMI which leads to a value proposition that goes beyond providing a high quality affordable salmon product for consumers. Such a sustainable value proposition in offshore must also meet the expectations of these various stakeholders (local communities, NGOs, regulators, etc) in order to obtain both government and social license to operate.

Accomplishing all this will be impossible with purely internal resources. When considering the relevance of transformational dynamic capabilities for successfully innovating on a firm's business model, Teece (2023) points out that filling gaps in these kinds of capabilities requires "internal development, acquisition, or alliance" (p. 121). Companies working with the uncertainty and challenges presented by offshore

may need to develop additional internal resources, but they will also need to engage with the knowledge and expertise of external researchers, partners, suppliers, and government agencies. This means that the ability to cooperate with and nudge these external partners will become both a key activity and key resource in a sustainable offshore business model. Succeeding with SBMI and delivering on these business model component outcomes will hinge upon firms' ability to address organizational barriers and drivers as identified in Paper III and workshopped as part of the tool developed in Paper IV, as it is through the mitigation of organizational barriers and boosting of organizational drivers that firms can develop the dynamic capabilities needed to actually engage in this kind of SBMI.

Based on our case analysis, we observed the presence of some drivers (valuing business sustainability, collaborative innovation, patient investments, public-private collaboration, and people capability development) which could be further boosted through internal initiatives; however, it is also important for firms to consider boosting those drivers which were not present (e.g. balancing shareholder and stakeholder value, making patient investments, and creating an enabling innovation structure). Firms in this context could pay particularly close attention to balancing shareholder and stakeholder value and prioritizing a strategic focus on SBMI. The former could take the form of deeper engagement with the stakeholder challenges presented by an offshore business model. Traditionally, a large number of small coastal communities have benefited from the job creation and industry offered by inshore aquaculture, while an offshore business model is likely to create a much smaller number of 'winners' as the supporting coastal infrastructure becomes situated in a comparatively limited number of locations. The latter could involve a more dedicated strategic focus on SBMI through setting aside additional resources for this kind of activity (something which itself is an operational driver of SBMI). Up until now, one could argue that a great deal of the sustainability-focused activity which appears in these firms' annual reports is somewhat ad hoc and driven by regulatory requirements and growing public pressure, rather than being reflective of a long-term sustainability strategy. A more strategic focus on SBMI would take a holistic approach to assessing the complex business model presented by a sustainable

approach to offshore aquaculture and dedicating more resources to the pursuit of this business model.

5.2. Contribution to theory

The research conducted as part of the dissertation makes several contributions to theory.

In addressing the design-implementation gap of sustainable business model innovation (Geissdoerfer et al., 2018; Baldassarre et al., 2020), the dissertation developed practical tools, and this practical contribution is considered above in Section 5.1. As part of and in addition to this tool development process, Papers I, II, III and IV also developed theoretical insights around effectuation theory, organizational design, dynamic capabilities, and SBMI. Figure 1 in Section 1.3 offers a visual representation of how both theory and tools fit together within the scope of the dissertation's four papers.

Traditionally, effectuation theory has been operationalized in entrepreneurial contexts as a distinct approach to creating value (Sarasvathy, 2001). The dissertation builds on the effectuation literature and advances effectuation theory in two complementary but distinct directions as part of the overall project of helping to bridge the design-implementation gap of SBMI. First, Paper I connects effectuation theory with responsible innovation and sustainability. The connection with responsible innovation is novel and helps to fill a gap in the responsible innovation literature around how responsible innovation can better engage with real-world innovation. The connection between effectuation and sustainability — both in terms of innovation activity broadly, as well as how we specifically conceive of the forecasting and assessment of sustainability impacts — is particularly valuable. Up until now, the effectuation literature has only just begun to engage with sustainability (Johnson & Hörisch, 2021; Long et al., 2021). Given the rich and varied literature around effectuation and its relevance for new venture creation and entrepreneurial thinking, the managerial literature on sustainability stands to gain much from increased engagement and linking with effectuation theory. Effectuated thinking is credited with driving substantial value creation in startup contexts, but its application

in corporate contexts has been limited, with recent research arguing that better exploitation of effectuated thinking in corporate innovation could drive better outcomes (Chesbrough & Tucci, 2020). Based on the argument presented in Paper I, we posit that the same holds true for sustainability-focused innovation: that bringing effectuation theory to bear on sustainability contexts can contribute to seizing more and varied opportunities for creating sustainability impacts. This argument is novel and will require future exploration and research, including longitudinal studies with quantitative before-and-after comparative measurements of key environmental indicators (e.g. via life cycle assessment) to determine the extent to which effectuated thinking can drive such outcomes. Further, it is still unknown to what extent specific effectuation principles might lend themselves best to driving sustainability outcomes. However, regardless of these remaining gaps, we maintain in Paper I that thinking in effectuated terms can help us avoid cognitive lock-in when conceptualizing sustainability impacts, seize opportunities for impact when they emerge, create new impact opportunities, and engage a broader range of stakeholders in innovation activity generally and impact assessment and forecasting, as evinced in our experience working with the effectuated concept of a Responsible Innovation Lab. Multi-stakeholder collaboration is key to succeeding with implementation of SBMI, as echoed in the results of Paper III (where organizational barriers and drivers related to collaboration are shown to be particularly important) and as described presently in connection with Paper II.

Indeed, Paper II of the dissertation further contributed to and expanded effectuation theory in the context of the design-implementation gap by exploring its complementarity with the Lean Startup approach. This paper outlined the similarities and differences between the approaches, and went one step beyond pure analysis by developing a workshop process tool which could combine the strengths of both. We found that the circular business model experimentation process benefited in unique and novel ways thanks to the combination of effectuation theory with Lean Startup, and that experimentation with circular business models could be conducted more effectively in this manner than by simply leveraging the Lean Startup approach on its own. Asking effectual questions and engaging in effectuated thinking (for example, following the ‘pilot in the plane’ and ‘lemonade principle’) aided circular innovators

in identifying where they could create opportunities to drive the most impact, despite challenges they might face. Connecting with relevant stakeholders for collaboration (the 'crazy quilt' principle) afforded innovators the opportunity to design and scale up experiments. Further, this kind of multi-stakeholder collaboration could assist circular business model innovators in developing more system-wide and scalable solutions in general, instead of getting stuck in circular solutions which are localized to specific geographies. This finding and contribution builds upon previous research related to the importance of stakeholder collaboration — particularly in the ideation and experimentation phase of the SBMI and CBMI process — for delivering sustainable and circular outcomes (Brown et al., 2021; Guldmann et al., 2019; Stubbs & Cocklin, 2008; Yunus et al., 2010).

The dissertation also advances the emergent body of theory around the relationship between organizational design, dynamic capabilities, and sustainable business model innovation. Recent research has just started to explore these connections (Leih et al., 2015; Teece, 2018; Bocken & Geradts, 2020), with organizational design still considered something of a black box in the business model innovation context (Foss, 2023). Paper III explicates these relationships and explores how they play out in a particular industry context. In particular, Paper III found that organizational culture (as an element of organizational design) plays an extremely important role in developing the dynamic capabilities for SBMI. Teece (2018) attempts to offer a simplified picture of how strategy interacts with dynamic capabilities and business model innovation, but pays inadequate attention to organizational culture, lumping it in as a transformative dynamic capability. Meanwhile, Bocken & Geradts (2020) only consider organizational culture in terms of the barriers and drivers they present. Paper III moves this emergent theoretical discussion forward by arguing that organizational culture forms the backdrop on which organizational design, the development of dynamic capabilities, and the implementation of SBMI actually play out (Figure 12). In this way, Paper III concludes that organizational culture not only drives strategy and operations (Bocken & Geradts, 2020) — it also *delimits* the strategic and operational activity which can occur in a firm context, particularly when it comes to developing dynamic capabilities for SBMI (Geradts & Bocken, 2019). Without clear values and norms for sustainability and routines related to radical

innovation — that is, without the right organizational culture — firms will struggle to develop the dynamic capabilities needed for successful SBMI. This showed up in the Paper III case, for example, in the form of cultural ambiguity stemming from a recent corporate merger, which stymied the development of transformation-type dynamic capabilities.

Indeed, the distinction between 'innovation as R&D' and 'radical innovation' is especially relevant when it comes to the interplay between organizational design, dynamic capabilities, and SBMI. Conventional R&D processes are of course a valuable and necessary firm activity, but they are not highly correlated with more radical business model innovation activity or radical innovation outcomes in general (Osterwalder & Pigneur, 2020). For example, Tesla's R&D budget in 2018 was just 10% that of Volkswagen's ($1.5B compared to $15.3B), but its innovation outcomes were arguably far superior and far more radical (Osterwalder & Pigneur, 2020). This implies that companies aiming for radical innovation should therefore supplement conventional R&D with a willingness to work on business model innovation, through developing the dynamic capabilities needed to discover and create new opportunities (sense), test and experiment with new ideas and business models grounded in these opportunities (seize), and manage a portfolio of such activity in a way which contributes to the organization's long-term movement into new markets and verticals with new products, services and business models (transform) (Osterwalder & Pigneur, 2020). Developing these capabilities, however, is dependent upon cultural, strategic and operational alignment (Slawinski et al., 2017) around the value and importance of business model thinking and business model innovation.

Further, Paper III revealed that firms aiming to overcome the SBMI design-implementation gap must work to develop core values around sustainability. This may seem like an obvious conclusion, but its importance cannot be overstated. We observed many firms claiming to have sustainability as a 'core value', but in fact found this self-assessment to be a kind of confounding factor which inhibited radical SBMI. This was because of how sustainability was often understood in practice: as incremental improvements in the existing business model, rather than radical sustainability improvements embedded in a new (or substantially altered versions of

the existing) business model. Incremental improvements in sustainability are of course still worthwhile, and we conclude in Paper III that this kind of incrementalism is in some sense a type of what Teece (2018) calls a second-order microfoundation dynamic capability. However, following this second-order vs. higher level dynamic capability distinction, this incremental approach to sustainability will not deliver radical sustainability improvements, as it forms an inadequate foundation for the kind of 'higher order' sensing, seizing, and transforming capabilities needed for what Teece (2018) considers to be substantial BMI (and what we in this case consider substantial SBMI). In summary, firms' sustainability strategies may be too incremental to drive the outcomes they want and need, and this incrementalism may be grounded in core values which must be addressed in order to drive better strategic and operational outcomes for sustainability.

In this same vein, a key and novel contribution of the dissertation was It further developed the theoretical insight that since cultural transformation can itself be considered a type of higher order dynamic capability, cultural challenges which fail to enable the dynamic capabilities needed for SBMI can be especially hard to address and correct, as companies can find themselves stuck in a chicken-and-egg scenario where cultural shifts become a particularly heavy lift. Given the essential role of organizational culture in driving strategic and operational outcomes for sustainability (as discussed above and at length in Paper III), this insight is particularly salient.

Additionally, the research conducted here confirms the observation in Bocken & Geradts (2020) that barriers and drivers at the level of organizational culture are directly related to barriers and drivers at the strategic level, which in turn connect to operational barriers and drivers. Paper III found that aquaculture firms attempting to innovate their business models for sustainability were encountering some of the same barriers and drivers identified in Bocken & Geradts (2020), including valuing business sustainability (a cultural driver); dominant focus on exploitation (a strategic barriers); collaborative innovation and patient investments (strategic drivers); fixed resource planning and allocation (an operational barriers)l; and people capability development (an operational driver). Paper III identified additional organizational barriers and drivers in the case context which can either facilitate or inhibit the

development of the dynamic capabilities needed for SBMI, including cultural ambiguity (a cultural barrier); collaborative challenges and cognitive challenges (strategic barriers); and public-private collaboration (a strategic driver).

Finally, by engaging with the design-implementation gap of SBMI, the dissertation advanced the literature in this area. Paper III observed how this gap plays out in terms of the interaction between organizational design, dynamic capabilities, and SBMI in a particular industry context. Bridging the design-implementation gap implies that firms must address fundamental organizational design issues, including for example the cultural ones mentioned above. Papers I, II and IV developed tools which can aid firms in bridging this gap, with the tools in papers II and IV developed according to a rigorous design science research process. These papers further developed generalizable propositions and lessons (described in Section 4.3) which advance theory around how to bridge the design-implementation gap.

5.3. Contribution to methodology

The dissertation advanced the state of the art in methodological approaches to doctoral research in management which aims to both contribute to practice and facilitate the green transition. The case study approach adopted in Paper III incorporated elements of action research as part of a unique public-private innovation project. While this approach was not without its challenges, it provided both myself and the second author with not only unique insight into the case context, but also the ability to actively shape more sustainable outcomes with ripple effects into industry and the emerging value chain around offshore aquaculture. Future research in such public-private innovation contexts could adopt a similar inductive-turned-abductive positioning which embraces the ambiguities presented by an action research-influenced approach to conducting a case study.

Even more centrally, the dissertation makes a substantial contribution to the state of the art in design science research and the development of tools which can be utilized by both researchers and practitioners working with sustainable and circular business model innovation. While there has been a growth in SBMI and CBMI tools in recent years (Pieroni et al., 2019), many of them suffer from design flaws, related in part to

an insufficiently rigorous process of design and development (Bocken et al., 2019b). Paper I developed two tools grounded in the conceptual synthesis of effectuation theory, responsible innovation, and sustainability impacts, while due to space constraints opting to focus more on a theoretical contribution than on a rigorous tool development process. Papers II and IV, however, adopted a rigorous design science research method in order to develop the Circular Experimentation Workbench and Sustainable By Design tools. Beyond their direct value for practitioners (discussed in Section 5.1), the methodological approach used to develop the tools provides an important reference and benchmark for researchers aiming to design, develop, and test tools which can help advance the green transition and bridge the gap between research and practice.

5.4. Limitations of the research

While the research presented here is the culmination of over three years' worth of focused effort, it is not without its limitations.

First, the approach taken by the dissertation aimed to synthesize multiple strands of literature in an effort to further bridge the design-implementation gap of SBMI. The dissertation brought together a wide range of concepts including responsible innovation, effectuation theory, circular business models, Lean Startup, sustainable business model innovation, organizational design, and dynamic capabilities. A necessary trade-off of bringing together so many strands of literature was that some of these strands could be investigated more deeply and engaged with more substantially than others. It is therefore reasonable to conclude that a deeper dive into a particular strand of literature could have generated even more insights. Future research may therefore wish to investigate some of the connections made here in greater detail: for example, the complementary relationship between effectuation and Lean Startup, or the ways in which the 'culture gap' can be addressed in order to in turn contribute to bridging the design-implementation gap of SBMI in particular organizational contexts. Suggestions for future research are further described in Section 5.5.

The methodological approaches taken in the papers which comprise the dissertation are themselves characterized by certain limitations, which in turn translate to limitations at the level of the dissertation. The case study approach in Paper III was situated in a very unique public-private innovation and industry context, and while this led to correspondingly unique and revelatory insights, it also means more limited generalizability. For example, while the results may be generalized to other primary industries, it is less clear that they are generalizable to non-primary industries. Further, given the influence of the public-private innovation context on the observed activity of firms, it is unclear how dependent the insights derived from the project were on these particularities. Future research could therefore further examine the interactions between organizational design, dynamic capabilities, and SBMI in other industries and contexts in order to either further validate or challenge the results of the dissertation. Further, by incorporating aspects of action research, it was sometimes difficult to maintain sufficient observational distance from the case context, and participation in the project may have colored certain observations and conclusions (Wittmayer & Schäpke, 2014). It is also worth noting that the project is still underway at the time of submission, and given that the observations discussed here were made midway through the project, different outcomes which present at the project's conclusion could lead to new insights around organizational design, dynamic capabilities, and SBMI.

The design science research approach in Papers II and IV is also marked by specific limitations. First, developing tools in a rigorous way brings inherent challenges, particularly given the demands placed upon the development process by the need to publish peer-reviewed research. In a non-academic context, these tools could be iterated upon indefinitely and would almost certainly improve with further refinement in light of continued testing and pivoting. They could also be used with a wider range of organization types (and a larger number of organizations) to make the results and tools more generalizable across industries and contexts. However, the Communication phase of the design science research process (figure X earlier in dissertation) demands that a tool be considered 'finished' at a certain point so that results can be submitted for peer review and publication. It is therefore worth noting that while these tools were rigorously developed, they could almost certainly benefit

from further testing and refinement. Additionally, design science research thoroughly embeds the researcher(s) in the development process in an action-oriented way. Much like in an action research case study, it can be difficult to maintain a neutral point of view with respect to the outcomes and assessment of the tools. One might also unintentionally influence the testing outcomes in a positive way simply because of one's experience as a facilitator. A less experienced facilitator may have achieved worse outcomes in a test workshop setting, resulting in lower user feedback scores and prompting more refinement and re-design of the tool as compared to the amount of refinement in Papers II and IV. Finally, the methodological approach selected was non-longitudinal in the sense that it did not incorporate follow up with workshop participants to measure the long-term outcomes of the circular experiments conducted (Paper II) or the organizational assessment of barriers and drivers (Paper IV). Future research could therefore leverage either of these tools as part of a longitudinal study to determine long term outcomes (e.g. successful circular business models or organizational design outcomes which contribute to SBMI), as further described in Section 5.5.

Finally, it is possible to critique the tools developed here as insufficiently 'strong' in their approach to sustainability. For example, despite their focus on circularity and sustainability, the tools do not encourage users to fundamentally question the assumptions of growth-based economic development or engage with emergent discussions around new degrowth models of economic activity, where a broader sociocultural shift would be central in effectively overcoming dominant modes of growth-based thinking (Kallis, 2011; Kallis et al., 2018). Degrowth scholars have in fact rejected popular conceptions of the circular economy (as for example captured in the slow, narrow, close, regenerate approach proposed in Paper II) as a false 'green growth narrative' which falls apart under scrutiny and is an inadequately 'strong' form of sustainability (Schröder et al., 2019). I acknowledge this as a fair critique and limitation of the work conducted here, but would offer a twofold response. First, circular business models are only just coming into existence, as noted in Paper II. As Schröder et al. (2019) point out, the circular economy concept itself is also still in its infancy, and rather than serving as an either-or point of reference, degrowth thinking could help to shape our conceptualization of the circular economy broadly and

circular business models specifically. The strong vs. weak, degrowth vs. circular/sustainability dichotomy is therefore arguably unhelpful and unnecessarily antagonistic. For example, prioritizing regeneration as part of a circular business model, or a nature-positive approach as part of a sustainable business model, could result in net positive outcomes in particular business cases, even if these businesses do not challenge the broader economic growth narrative within which they are embedded. Secondly, while it is fair to critique the tools here as potentially inadequately 'strong' from a sustainability perspective, my aim in developing them was to make a pragmatic near-term contribution to practice, one which would effectively make big companies 'less bad'. The goal was not a perfect outcome, but something which is at least an improvement over the status quo. We clearly have a long way to go before we manage to maximize wellbeing and prosperity in a way that also conserves limited natural capital. The aim of the tools developed here was to take a step in this direction, while acknowledging that the road is long and inevitably brings many unexpected turns — some of which may take us into entirely new socioeconomic paradigms.

5.5. Future research

In addressing the design-implementation gap of SBMI, the research conducted for the doctoral project touched on a wide range of topics, including responsible innovation, effectuation, sustainability impacts, sustainable and circular business model innovation, organizational design, and dynamic capabilities. There are many fruitful research avenues to pursue in each of these areas individually, as well as at their various intersections. Here, I suggest a few directions which build on the work conducted as part of the dissertation.

While I have started a conversation around how responsible innovation, effectuation, and sustainability impacts are related, the Responsible Innovation Tool, Responsible Impact Tool, and the concept of a Responsible Innovation Lab (RIL) give researchers and practitioners a framework and toolkit to continue exploring these relationships, both in research and in practice. More research is needed on the relative advantages and challenges presented by this framework in practice. Public-private innovation

projects might opt to include a RIL as part of their project execution, with researchers improving both the framework and associated tools through future iterations.

My research examined how circular business model experimentation might benefit from the combination of effectuation and Lean Startup principles. Future research using the Circular Experimentation Workbench could contribute additional insight into the process of CBM experimentation. In particular, though we did observe that including additional stakeholders through effectuation processes seemed to contribute to the development of more systematic circular solutions, we did not test for this directly, and this is something future research could examine more closely. We observed that a number of similarities and synergies exist between the Lean Startup and effectuation approaches, and future research might delve further into these synergies. The research we conducted also focused more on some effectuation principles than others, and in particular there is room to look more closely at the effectuation principle of 'affordable loss' in future research. Lastly, while the tool we developed and the workshops we conducted ended with the design of various experiments, it was out of scope to follow how practitioners conducted these experiments and measure outcomes. Future research might therefore take a longitudinal approach to studying the success or failure of these experiments, and the impact of effectuation and Lean Startup on these outcomes.

The research presented here also examined the relationship between organizational design, dynamic capabilities, and SBMI, both through design science research and a case study. The Sustainable By Design tool could be applied in future studies both to further assess its effectiveness in different corporate contexts, as well as to uncover new insights about how various organizational barriers and drivers present in different industries and organizations. Longitudinal studies could follow up on its long-term effectiveness in helping to bridge the design-implementation gap of SBMI. Meanwhile, the case study revealed the organizational barriers and drivers present in Norwegian salmon aquaculture and highlighted the challenges these firms face in developing the dynamic capabilities needed to succeed with SBMI when attempting to move their operations offshore. While this advances the literature at the intersection of organizational design, dynamic capabilities, and SBMI, future

research could further examine how these concepts present and interact in different industry and organizational contexts. As the world becomes more volatile, uncertain, complex, and ambiguous (VUCA), dynamic capabilities and SBMI are increasingly relevant as firms need to adapt to rapidly developing and shifting externalities and pressures (Bocken & Konietzko, 2022; Schoemaker et al., 2018). Understanding the challenges firms face in attempting to develop these capabilities in different case contexts could therefore advance research in this area while also providing useful insights for practitioners.

More broadly, the aim of this research was to help bridge the design-implementation gap of SBMI. While I believe I have made a useful contribution in this area by both developing useful tools and actionable insights for practitioners as well as advancing the theory in this area, we are still far from a state of affairs where businesses are broadly succeeding with SBMI. Future research should continue to address this important gap. A substantial contribution can be made through engaged scholarship, grounded in a practice-oriented epistemology and leveraging methodological approaches such as the ones employed here.

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Journal of Cleaner Production 376 (2022) 134324

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Effectuated sustainability: Responsible Innovation Labs for impact forecasting and assessment

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ARTICLE INFO

Handling Editor: Cecilia Maria Villas Bôas de Almeida

Keywords:
Responsible innovation
Sustainability impact
Responsible innovation lab
Impact assessment
Sustainable business model innovation
Effectuation

ABSTRACT

Considering intractable uncertainties and the wicked nature of many sustainability challenges, there is a need to both forecast and assess the potential for improvements in sustainability with new ventures. While it is tempting to think of forecasting in terms of 'predicting outcomes', such an interpretation assumes a causal logic, failing to acknowledge the effectuation processes often at work in sustainability-focused innovative and entrepreneurial activity. In this paper, we argue that effectuation theory implies a new way of conceptualizing sustainability impact in such contexts. Leveraging the Responsible Research and Innovation (RRI) concept, we develop an arena in which both impact forecasting and assessment can be achieved in line with effectuation processes via what we term a Responsible Innovation Lab (RIL), understood as a type of living lab. After examining the concept of RRI, we delve into effectuation theory, deriving relevant insights for sustainability impact in new venture contexts. We then present the RIL as a conceptual synthesis of RRI, living labs, and effectuation theory. Further leveraging effectuation theory, we develop two tools (the Responsible Innovation Tool and Responsible Impact Tool) to both guide multi-stakeholder sustainability-focused innovation activity in a RIL, as well as facilitate the development of context-specific methodologies for forecasting and assessing sustainability impacts.

1. Introduction

Research interest in innovation for sustainable development has increased dramatically in recent decades. Governments increasingly implement innovation-centered economic policy designed to drive innovation, improve competitive advantage, foster economic growth, and (more recently) address the UN Sustainable Development Goals (Frenken, 2017; Schot and Steinmueller, 2018). In the European context, the notion of Responsible Research and Innovation (RRI) has received increasing attention from both researchers and policymakers. Beginning with von Schomberg's work in connection with the European Commission (von Schomberg, 2011) and Stilgoe et al.'s (2013) development of a framework for responsible innovation, innovation research increasingly seeks to incorporate aspects of reflexivity and normative directionality into innovation activities.[1] This 'normative-reflexive turn' is particularly relevant in the context of sustainability-focused innovation.

Traditional tools for and approaches to innovation typically revolve around explorative ideation processes with the ultimate aim of exploiting a product or service and accompanying business model. But when innovation is intentionally linked with a sustainability mission, even greater focus is needed on exploration and experimentation (March, 1991; Chesbrough and Tucci, 2020; Mazzucato, 2018; Coenen and Morgan, 2020; Gibbs & O'Neill, 2016; Bergset and Fichter, 2015). Testing, reflexivity, and pivoting are critically important when innovation processes intentionally seek to achieve improvements in sustainability markers and avoid risks of greenwashing, quick fixes, and other aspects of solutionism (Morozov, 2013). This is all the more salient when startups, entrepreneurs, and corporate intrapreneurs engage in innovation activities aimed at the development of new, sustainability-focused ventures and value chains.

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[1] The same can be said for entrepreneurial activity.

https://doi.org/10.1016/j.jclepro.2022.134324
Received 6 September 2021; Received in revised form 30 June 2022; Accepted 20 September 2022
Available online 24 September 2022

For sustainability-focused innovative ventures, there is the double challenge to *forecast* the potential for improvements in sustainability, as well as *assess* sustainability improvements during and following various firm-level activities. Firms failing to do so will struggle to account for whether innovation genuinely contributes to sustainability improvements. Importantly, forecasting and assessment are inherently intertwined and cannot be separated or bracketed considering the future-minded orientation and temporality of sustainability. However, while it is easy to think of forecasting in terms of 'predicting outcomes' (e.g., achieving desired effects such as reduced emissions), this interpretation takes an overly simplistic position on how sustainability-focused innovation often unfolds: it is not purely causal, but often effectuated, a topic which we explore in Section 2.2 (Sarasvathy, 2001). Understood in these terms, forecasting the sustainability outcomes of innovative ventures — their 'sustainability impact', understood as a "substantive contribution … to sustainable development along the three dimensions of economic, social, and environmental value creation" (Trautwein, 2021, p.1) — is both complex and challenging, as uncertainties are intractable and problem-solution framings often wicked (Rittel and Webber, 1973; Goldstein et al., 2008). At the same time, forecasting and assessment can be context-sensitive and require the input of a range of actors — firms, policymakers, researchers, NGOs, and the general public — in determining what data to collect, how it should be categorized, what outcomes are most important to which stakeholders, and how successes and failures are characterized and measured (Impact Management Project, n.d.).

Related research gaps exist within both the Responsible Research and Innovation (RRI) and effectuation literatures, offering fruitful opportunities for connecting RRI, effectuation, and sustainability impacts. While RRI takes an openly normative stance towards innovation, it often lacks "clear practical guidelines" for real-world implementation (Iakovleva et al., 2021, p. 1; Coenen and Morgan, 2020). The RRI literature has maintained a research-intensive focus, largely failing to account for how knowledge is put into practice via real-world innovations. Too much attention has been paid to research-oriented innovation, and too little to firm-level activity. More knowledge is also needed around how to drive knowledge co-creation in multi-stakeholder contexts, balancing economic, environmental, and social considerations (Jakobsen et al., 2019). Meanwhile, although research on effectuation has begun to link the concept with questions of sustainability — and while preliminary findings indicate that certain aspects of effectuation can have a positive impact on sustainability orientation and outcomes — such research is in its infancy, and more work is needed to explore the connections between effectuation and sustainability (Johnson and Hörisch, 2021; Long et al., 2021).

Our research question is therefore:

RQ. How can the concepts of Responsible Research & Innovation and effectuation inform firm-level sustainability-focused innovation activity as well as the forecasting and assessment of sustainability impacts for new ventures?

In this paper, we suggest one way in which both forecasting and assessment can be framed in an RRI context while incorporating aspects of effectuation theory via what we term a Responsible Innovation Lab (RIL), understood as a particular type of living lab, a "research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts" (Eriksson et al., 2006, n.p). Further, we present two tools which can be leveraged in a RIL for both guiding innovation activity as well as negotiating the challenges and dilemmas associated with forecasting and assessing sustainability impacts in the face of effectuation processes.

The paper is divided into five sections. Section 2 provides the theoretical and conceptual background for the paper. We first review the RRI concept before delving into effectuation theory, deriving relevant insights for conceptualizing sustainability impacts in new venture contexts. In Section 3, we present the Responsible Innovation Lab as a type of living lab which combines RRI with effectuation theory. We then proceed to develop two tools for practitioners engaged in a RIL, combining insights from RRI with effectuation theory. Section 4 discusses the implications of the RIL and accompanying tools for sustainability impact forecasting and assessment, in light of effectuation theory. Section 5 offers a conclusion.

2. Background

2.1. Responsible research and innovation (RRI)

As Stilgoe et al. (2013) point out, the idea of responsible innovation[2] is "both old and new" (p. 1568). But with growing awareness of the potential for technological innovation to lead to both exponential benefits and unforeseen harms, public discussion of innovation increasingly foregrounds the importance of responsibility (Stilgoe et al., 2013; Jonas, 1984; Collingridge, 1980; Beck, 1992; Groves, 2006). Various definitions of RRI have appeared in the literature. Beginning with von Schomberg, RRI is characterized as:

> "A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (von Schomberg, 2011, p.9).

This definition reflexively considers various dimensions of innovation in terms of responsibility, but does not characterize the responsible innovation process in a prescriptive way: it avoids first order normative questions of what innovation pathways we ought to pursue, as is often the case with sustainability pathways and missions (Schlaile et al., 2017). In their seminal paper on RRI, Stilgoe et al. (2013) offer a "broader" definition:

> "Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present" (p. 1570).

More recently, a review of the RRI literature by Thapa et al. (2019) analyzes the conceptual underpinnings of RRI across 126 papers. The authors' thematic analysis concludes that RRI is understood in the reviewed literature as:

> "Collective stewardship of science and innovation in order to meet the needs and expectation of society and to ensure inclusive, responsible and sustainable development" (p. 2476).

These last two definitions imply greater normative directionality. Innovation processes must not only be ethically acceptable, sustainable, and socially desirable: they should also 'take care of the future,' something which involves first order normative considerations (though as Iakovleva et al. (2021) note, this "normative loading" is not always accompanied by "clear practical guidelines toward implementation practices" (p. 1)).

Stilgoe et al. (2013) propose a now widely leveraged analytic framework for RRI comprised of four dimensions: anticipation, reflexivity, inclusion, and responsiveness. "Anticipation prompts researchers and organizations to ask 'what if … ?' questions," employing "systematic thinking aimed at increasing resilience, while revealing new opportunities for innovation" (p. 1570). Inclusion means involving "new voices in the governance of science and innovation as part of a search for legitimacy" (p. 1571). Reflexivity implies "holding a mirror up to one's own activities, commitments and assumptions, being aware of the limits

[2] Note that the RRI literature often uses the terms 'responsible research and innovation' and 'responsible innovation' interchangeably (Jakobsen et al., 2019).

of knowledge" (p. 1571). Finally, responsiveness implies "capacity to change shape or direction in response to stakeholder and public values and changing circumstances" (p. 1572). Jakobsen et al. (2019) argue that this multidimensional framework offers a "promising approach" towards reaching "general agreement on the principles, methods, and tools for achieving 'beneficial' societal outcomes or on how to stimulate the 'right' processes to achieve these goals" (p. 2331).

Jakobsen et al. (2019) further suggest RRI should be broadened in several directions. It should go beyond a research-intensive focus to account for how knowledge is put into practice via real-world innovations, accounting for innovation processes which are not strictly research-oriented. Broadening RRI research to include more firm-level innovation implies greater contextuality, requiring consideration of the material, organizational, and discursive aspects of the innovation process, as well as contextual embedding of innovation in terms of territoriality (cf. Coenen and Morgan, 2020). This results in a "responsible innovation complex" where materiality, organization, and discourse are connected within a territorial context (Jakobsen et al., 2019, p. 2334). Finally, there is a literature gap around how to drive multi-stakeholder knowledge co-creation, balancing economic, environmental, and social considerations. Jakobsen et al. (2019) argue that this type of co-creation could occur in a living lab context — a point to which we return in Section 3.

2.2. Effectuation

Considering intractable uncertainties and the wicked nature of many sustainability challenges, there is a need to both forecast and assess sustainability impacts when engaging in sustainability-focused innovation. While it is tempting to approach forecasting and assessment in a linear way, assuming the existence of straightforward causal mechanisms which can be analyzed to predict potential outcomes, sustainability-focused innovation processes themselves are often effectuated — a feature which frustrates attempts to frame impact forecasting in causal terms.

The causation-effectuation distinction comes from Sarasvathy (2001). Causation processes are those which "take a particular effect as given and focus on selecting between means to create that effect," while effectuation processes are those which "take a set of means as given and focus on selecting between possible effects that can be created with that set of means" (p. 245). If we imagine a chef preparing dinner for a client, they can prepare the dinner in one of two ways. They could select a meal ahead of time, purchase the needed ingredients, and cook the meal for the client. This would be a process of causation, as it "begins with a given menu and focuses on selecting between effective ways to prepare the meal" (p. 245). Alternatively, they could survey what ingredients and cookware are already in the kitchen and improvise a meal, engaging in a creative effectuation process which "begins with given ingredients and utensils and focuses on preparing one of many possible desirable meals with them" (p. 245). Following effectual rather than causal logics, entrepreneurs actively "shape and construct" their end goals over time, "making use of contingencies" to construct new business models, develop new value propositions, and reach new customers (p. 247). This type of effectuated pivoting can be observed both in the traditional startup context — for example, Slack's pivot from a failed gaming startup by commercializing what had originally been developed as an internal communication tool (Chen, 2021) — as well as in intrapreneurial business model innovation aimed at net zero carbon footprint, as in the case of Shell's 'Accelerate to Zero' program for enterprise-level customers (Shell, 2022).

In concrete terms, an effectuated logic prioritizes a 'mapping of means' as a starting point for new venture activity (Sarasvathy, 2001, p. 253). Actors might ask:

Who are we?

- What are our individual identities and background?
- Which physical resources do we have access to?
- What are the characteristics of our innovation ecosystem?

What do we know?

- What knowledge do we have as individuals?
- What organizational knowledge resources can we access?
- What technology can we leverage?

Who do we know?

- Who is in our individual network?
- Who is in our organizational network?
- Who is in our broader institutional network?

In contrast with causal thinking, effectuation further implies a distinct approach to thinking about new ventures, including affordable loss, alliances, knowledge, and future planning (Sarasvathy, 2001, p. 252):

Affordable loss.

- Causation: How do we maximize potential returns?
- Effectuation: How much loss is affordable, and how do we maximize our options through experimentation?

Alliances.

- Causation: Who are our competitors? How do we minimize risk through competitive analysis?
- Effectuation: Who can we ally ourselves with? How do we minimize risk by building strategic alliances and getting commitments from stakeholders?

Knowledge.

- Causation: What preexisting technical knowledge can we exploit for competitive advantage?
- Effectuation: What knowledge do we have that can help us exploit contingencies when they arise?

Future plannin\g.

- Causation: What can we predict, so that we can control outcomes?
- Effectuation: What can we control, so that we can worry less about predictions?

While effectuation has gained considerable traction in the entrepreneurial literature over the past two decades, researchers are only just beginning to make connections between effectuation theory and sustainability considerations. We argue that conceptualizing innovation activity as effectuated is especially relevant in the context of sustainability-focused new ventures, where it gives rise to unique considerations for both innovation activity in general as well as impact forecasting and assessment in particular. The notion of 'affordable loss' above provides a clear example. By emphasizing "affordable loss rather than expected returns," effectuated thinking prioritizes a multiplicity of future options over the maximization of financial returns in the short term (p. 252). While 'affordable loss' can be understood in a traditional sense (e.g., the amount of financial loss that can be absorbed during business experimentation processes), when sustainability is of prime importance, this thinking can be extended to include environmental externalities as well (e.g., carbon emissions or biodiversity loss). Further, in intrapreneurial contexts, effectuated thinking about affordable financial loss can help to offset barriers to sustainability-focused business model innovation such as a dominant focus on shareholder profit maximization and general "short-termism" (Bocken and Geradts,

2020, p. 6). By thinking in terms of 'affordable (financial) loss' rather than or in addition to 'expected returns', firms can institute culture-level shifts towards radical innovation aimed at achieving sustainability improvements. Such shifts at the organizational level can facilitate the development of dynamic capabilities, which in turn can lead to greater success with sustainable business model innovation in intrapreneurial contexts (Bocken and Geradts, 2020).

Effectuation theory also has major implications for how we conceptualize impact forecasting and assessment in new venture contexts, as illustrated by the concept of entrepreneurial opportunity. An ongoing discussion in the entrepreneurial literature examines to what extent opportunities are created or discovered (Barney & Alvarez, 2007; Venkataraman, 1997; Singh, 2001; Baron and Ensley, 2006; Read et al., 2009; Sarasvathy and Venkataraman, 2011). Opportunities can be understood as existing out there in the world, waiting to be discovered ("mountain climbing"), or as actively created by the actions of entrepreneurs ("mountain building") (Barney & Alvarez, 2007, p. 11). The opportunity creation perspective coheres with an effectuated view of entrepreneurial activity: through engaging in effectuation processes, entrepreneurs do not simply discover and subsequently exploit existing gaps in the market, but rather actively create and shape these very gaps. While this way of thinking about entrepreneurship has traditionally conceptualized 'opportunity' as economic opportunity, the same logic can be applied to impact opportunity. In other words, new ventures can and do actively shape the world around them, creating opportunities for impact. This fact underscores what makes the notion of impact forecasting so difficult in such contexts. While a new venture could in theory decide what predetermined impacts it intends to make, set targets and Objectives & Key Results (OKRs), and engage in activities to create these impacts, this causal approach ignores the effectuated reality of new venture activity. It also increases the risk of cognitive lock-in from the actors involved, who may fail to recognize their ability to actively create and shape new impact opportunities through previously unanticipated partnerships and activities. For example, an intrapreneurial innovation project initially aimed at reducing carbon footprint may evolve over time into one which emphasizes closing resource loops. Focusing on the latter as an impact goal could still contribute to emissions reduction, but a sole focus on emissions early on may reinforce a dominant logic which blinds managers to the opportunity to do more than only reduce emissions.[3] Avoiding such cognitive lock-in is increasingly important in corporate contexts, where the value of conventional Environmental, Social & Governance (ESG) approaches is under increasing scrutiny in light of 'carbon tunnel vision' and the lack of attention paid to broader environmental and social concerns (e.g., biodiversity) (Tett, 2022). The net zero obsession amongst many large organizations means that intrapreneurial ventures miss opportunities for regenerative business model innovation and broader stakeholder value creation. While embracing this level of flux and uncertainty in new ventures can be unsettling, particularly for intrapreneurial contexts within established companies (who may be more risk averse than startups), uncertainty is in fact an inherent feature of the wicked sustainability problems such ventures must address. As Berglund et al. (2020) point out, "industry standards, regulations, market segments, and product categories … exist primarily as social constructions," resulting in an environment which is "very much open to influence." As a result, "uncertainty [in entrepreneurial contexts] is overcome not by gathering correct information about the external environment but by participating in a process of gradually transforming it" (p. 829). This insight is also relevant for connecting RRI with firm-level, real-world activity: the conditions for 'responsible innovation' are not externally determined, but rather actively shaped.

While effectuation theory provides a new way of thinking about sustainability-focused ventures and their accompanying impacts, the question remains how to leverage these insights from effectuation theory in a practical context, where multiple stakeholders must navigate uncertainty while both achieving economic viability and simultaneously creating and enacting opportunities for sustainability impacts. The next section offers both a context and practical tools to facilitate this.

3. Responsible Innovation Labs: effectuated impact forecasting and assessment

3.1. The Responsible Innovation Lab concept

As discussed in Section 2.1, if it is to be practically relevant outside of the academic sphere, the Responsible Research and Innovation concept must be made relevant for firm contexts. Further, it should be better linked with knowledge co-creation in multi-stakeholder contexts, where actors are navigating economic, environmental, and social trade-offs (Jakobsen et al., 2019). The same goes for the insights derived above regarding effectuation theory: they should be made practically relevant for new ventures aiming for sustainability impact. Here, we propose a solution that can achieve all three of these goals, combining RRI with effectuation theory via a living lab context in what we term a Responsible Innovation Lab (RIL).

'Living labs' refer to a "user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts" (Eriksson et al., 2006, n.p.), as well as an "innovative research approach aimed at developing and testing new technologies and strategies to cope with complex social problems" (Nesti, 2018, p. 313; Mitchell, 2003). The living lab concept first appeared in the EU context in 2006 as part of the European Network of Living Labs (ENOLL) (Nesti, 2018). It then began to take on new forms in different contexts, e.g., Urban Living Labs (ULLs). ULLs differ from traditional living labs in terms of *user involvement* (a 'quadruple helix' of government, industry, research institutions, and the general public), *context of prototyping and development* (ULL innovations are typically co-created in a real-life context), and *open innovation focus* (the notion that "knowledge is diffused within society and that new solutions to problems can come and should be collected from inside to outside an organisation") (Nesti, 2018, p. 313–314; Chesbrough, 2003). Just as an urban development context often demands the implementation of a ULL, RRI and sustainability-focused innovation may be best served by a dedicated 'type' of living lab: the RIL.

The authors are involved in the establishment and operationalization of two RILs in Norway related to sustainability in salmon aquaculture. In both projects, practical knowledge generation is connected with a RIL, enabling knowledge co-creation between participating researchers, firms, policymakers, and NGOs. Informed by the living lab concept, the RILs will "emphasize experimentation understood as collective search and exploration processes in which a broad suite of stakeholders [reduce] uncertainty" surrounding effectuated innovation processes via experimentation and subsequent knowledge generation (Jakobsen et al., 2019, p. 2340).

In a RIL (where innovation activity is intentionally linked to sustainability outcomes), an openness not only to effectuation processes generally but also to the importance of ongoing experimentation explicitly is crucial, underscored by the notion of a Responsible Innovation *Lab*. Such experimentation could take the form of business modeling, designing novel approaches to Life Cycle Assessment (LCA) and impact assessment (e.g., recent work by MIT scientists to broaden the scope of LCA to include both positive 'handprints' as well as negative footprints (Norris et al., 2021)), testing of organizational innovations (e.g., multi-stakeholder development of policy and regulatory frameworks), new product and/or tech development, etc. At the same time, it

[3] There is considerable discussion in the management literature of how dominant logics can impede business model innovation, e.g. Chesbrough (2010). Here, we emphasize that clinging to predetermined goals and models of impact forecasting and assessment can have a similar effect on a venture's ability to create sustainability impact.

is worth noting that effectuation and experimentation are distinct processes which can and should complement one another other — a point discussed further in Section 4.

Openly embracing an effectuated approach to sustainability-focused new venture activity presents a unique set of challenges, unfolding in tandem with the need to achieve economic viability at an early stage, whether in the form of securing public funding support for an innovation project, attracting venture capital, or obtaining internal approval and buy-in for intrapreneurial projects within a larger organization. Balancing the need for economic viability with broader concerns around sustainability impacts can create dilemmas around economic and environmental/social trade-offs, which can be understood in effectuated terms: that is, in terms of the evolving business model(s) at play and the corresponding value propositions which emerge. In order to concretize how innovation activity in a RIL can address these challenges, we present two tools aimed at incorporating insights from RRI and effectuation theory. The tools further aim to facilitate a reflexive ('double-loop') learning process in the RIL context, bringing RRI considerations to bear on the effectuated logic of entrepreneurial experimentation (Argyris, 1977; Schön, 1983).

3.2. Tools for the Responsible Innovation Lab

Here, we present two tools for guiding RRI activity in the RIL context. Each tool emerges from a conceptual synthesis of RRI and effectuation theory. The Responsible Innovation Tool (Fig. 2) facilitates effectuated multi-stakeholder innovation activity in tandem with RRI considerations, while the Responsible Impact Tool (Fig. 3) aims to link RRI with effectuated, venture-specific approaches to sustainability impact forecasting and assessment.

The Responsible Innovation Tool (Fig. 2) draws on Jakobsen et al. (2019) who identify the need for analysis of responsible innovation processes in terms of "technology, infrastructure and natural resources" (the material dimension); "management, modes of organizing, networking between actors and policy frameworks" (the organizational dimension); "the knowledge behind innovations; new ideas and narratives about what are, should be and could become responsible innovation" (the discourse dimension); and "the geography of the innovation complex" (the territorial dimension) (p. 2333). It combines these dimensions of innovation with the four RRI activities of anticipation, inclusion, reflexivity, and responsiveness found in Stilgoe et al. (2013). While we agree with Jakobsen et al. (2019) that territory deserves consideration, we consider territory as embedded into material, organizational, and discursive considerations, and therefore do not treat it as an independent dimension. We therefore considered Stilgoe et al.'s (2013) RRI dimensions in terms of materiality (the first row of questions in the final tool), organization (the second row of questions), and discourse (the third row of questions), helping to concretize the otherwise abstract RRI dimensions.[4] At the same time, we opted to leave this terminology out of the tool itself in order to minimize jargon and improve user-friendliness. From here, we considered how the prototypical questions posed by effectuation theory in Section 2.2 might be fruitfully combined with the four RRI dimensions in material, organizational, and discursive terms. Particular attention was paid to the importance of accounting for multiple stakeholders in this context, including challenges presented by organizational boundaries, competition, and potential conflicts between organizational missions. Fig. 1 shows how these elements were combined to form the Responsible Innovation Tool (Fig. 2).

The tool is intended to facilitate effectuated 'even-if' experimentation in a RIL. It can be utilized as a starting point to generate discussion in a multi-stakeholder RIL workshop. It poses specific questions about a particular innovation activity with the aim of explicating assumptions about a given venture's goals, risks, and impacts that might otherwise remain tacit. This is especially important in a RIL, where a variety of actors may have radically different understandings of heavily contested concepts like sustainability. Participants are encouraged to consider the questions proposed by the tool, write their responses on sticky notes, and place them in the corresponding portion of the grid.[5] Responses can be removed and adjusted as discussion proceeds, with the aim of reaching a shared vision by the end of the session. In line with effectuation, participants should return to the tool over time in order to revisit emerging innovation activities, looking for new opportunities. This effectuated approach helps practitioners gain new insight into what has shifted, what new impact opportunities can be co-created, and which initial assumptions or goals may be hampering innovation processes.

While the Responsible Innovation Tool encourages reflection on innovation activity more generally, we also perceive a need to more directly connect responsible innovation and effectuation theory with the process of impact forecasting and assessment. In a new venture context, we believe it is important to design and adapt context-specific approaches to forecasting and assessment. However, without guidance, such a process is completely open-ended, and could potentially both fail to foresee issues connected to the unpredictability of effectuation processes, as well as exclude relevant stakeholders from the decision-making process. The process of designing a forecasting and assessment methodology should therefore cohere with the effectuated nature of firm innovation activity in a RIL. To facilitate this, we developed the Responsible Impact Tool (Fig. 3). To develop the tool, we first combined the four RRI dimensions with impact forecasting and assessment, resulting in a 2×4 matrix. We further added a column for 'Impact Action', to encourage participants to consider how forecasting and assessment activities can and should result in taking meaningful action for sustainability improvements. This is essential, as insights derived from forecasting and assessment (often at great expense in terms of firm resources) are of little use if they do not contribute to direct action and innovation activity. As with the Responsible Innovation Tool, we then considered how prototypical questions posed within the effectuation literature might be combined with the RRI dimensions (again, in a multi-stakeholder context) to generate salient questions for developing impact forecasting and assessment methodologies in the RIL context. This resulted in the question prompts found in the Responsible Impact Tool (Fig. 3).

The tool aids lab participants in developing and adopting venture-specific methodologies for impact forecasting and assessment. Leveraging the Responsible Impact Tool works similarly to the Responsible Innovation Tool: workshop participants review the questions posed by the tool, write their responses on sticky notes, and place them in the corresponding sections of the grid. The tool encourages dialogue between stakeholders in the RIL context, where assumptions about what is important to measure (and what is not) might not otherwise be made explicit. For example, while one group of stakeholders may be focused entirely on reducing carbon footprint, another might be concerned about biodiversity or resource loops. The tool is intended to generate constructive discussion about the tradeoffs associated with setting particular goals or adopting a specific methodology for impact assessment, while encouraging lab participants to regularly revisit the possibility of identifying and measuring emergent opportunities for sustainability impact. Instead of committing to a particular method of forecasting and assessment ex ante and sticking to it regardless of shifting innovation activities, participants can later revisit the task, seizing impact opportunities that could otherwise be missed when adhering to a causal logic.

[4] Combining materiality, organization, and discourse with the RRI dimensions was further inspired by a draft framework developed and presented by E. Uyarra, A. Fløysand, R. Njøs, and J. Rehner in the SALMANSVAR project.

[5] The tool can be leveraged in person, but can also facilitate digital workshops (with virtual sticky notes) via a platform such as Miro.

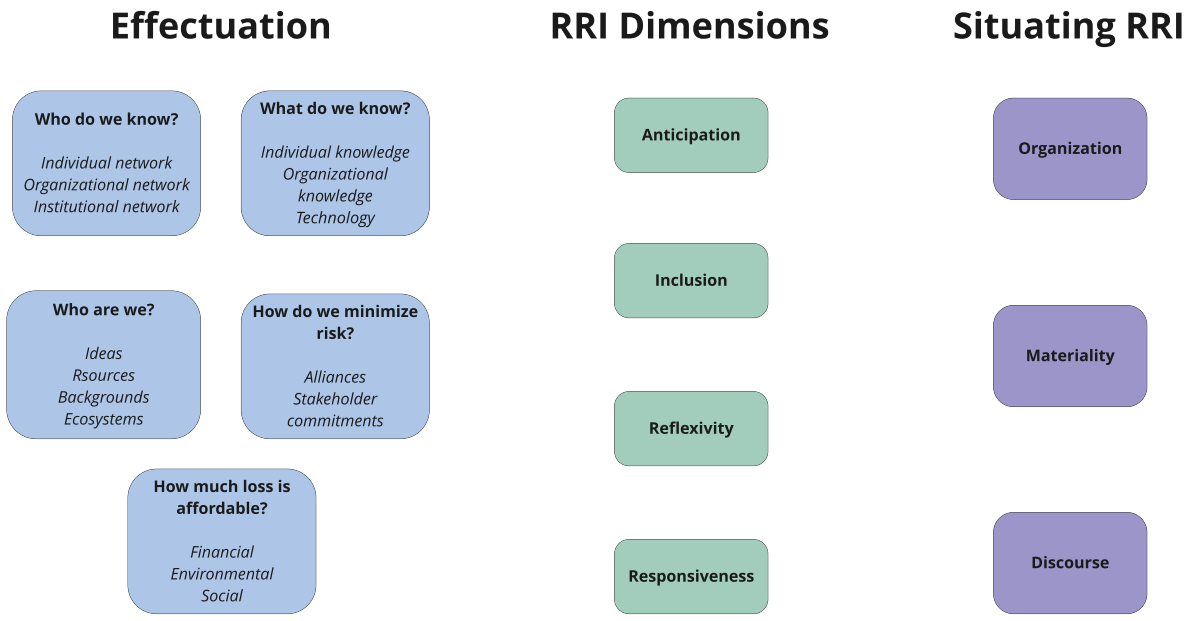

Fig. 1. Combining effectuation theory and RRI to develop the Responsible Innovation Tool (Fig. 2) and Responsible Impact Tool (Fig. 3).

Responsible Innovation Tool

Anticipate	Include	Reflect	Respond
Means *What resources do we have? What knowledge and technology can we leverage? What are our strengths & weaknesses as organizations and individuals?*	**Adoption** *How can we leverage our resources to increase adoption of the innovation?*	**Outcomes** *How does the innovation create sustainability impacts? Are we tied to causal thinking? How much loss is affordable, and for whom?*	**Emergence** *Where do we see new opportunities for sustainability impact? For innovation?*
Partners *What expertise do we have? Who is in our individual/organizational networks? What expertise can they offer?*	**Governance** *Who is involved in governance of the project/innovation(s)? Who can we ally ourselves with to make governance more inclusive?*	**Perceptions** *How do we conceptualize sustainability and responsibility differently as organizations and individuals? How does this impact innovation activity?*	**Pivoting** *How do we seize new opportunities? Where can we form new alliances across organizational boundaries?*
Dilemmas *What dilemmas and trade-offs exist between organizational missions? Where is there competition? What can we control? What can we bracket?*	**Framing** *Who frames the discussion around sustainability? Who is excluded? Where are conflicts emerging?*	**Legitimation** *Where can we create opportunities to foster legitimation of the innovation?*	**Opportunities** *What have we learned about each other than can be leveraged? How can new opportunities be co-created?*

Fig. 2. The Responsible Innovation Tool. Workshop participants place sticky note responses in the appropriate squares.

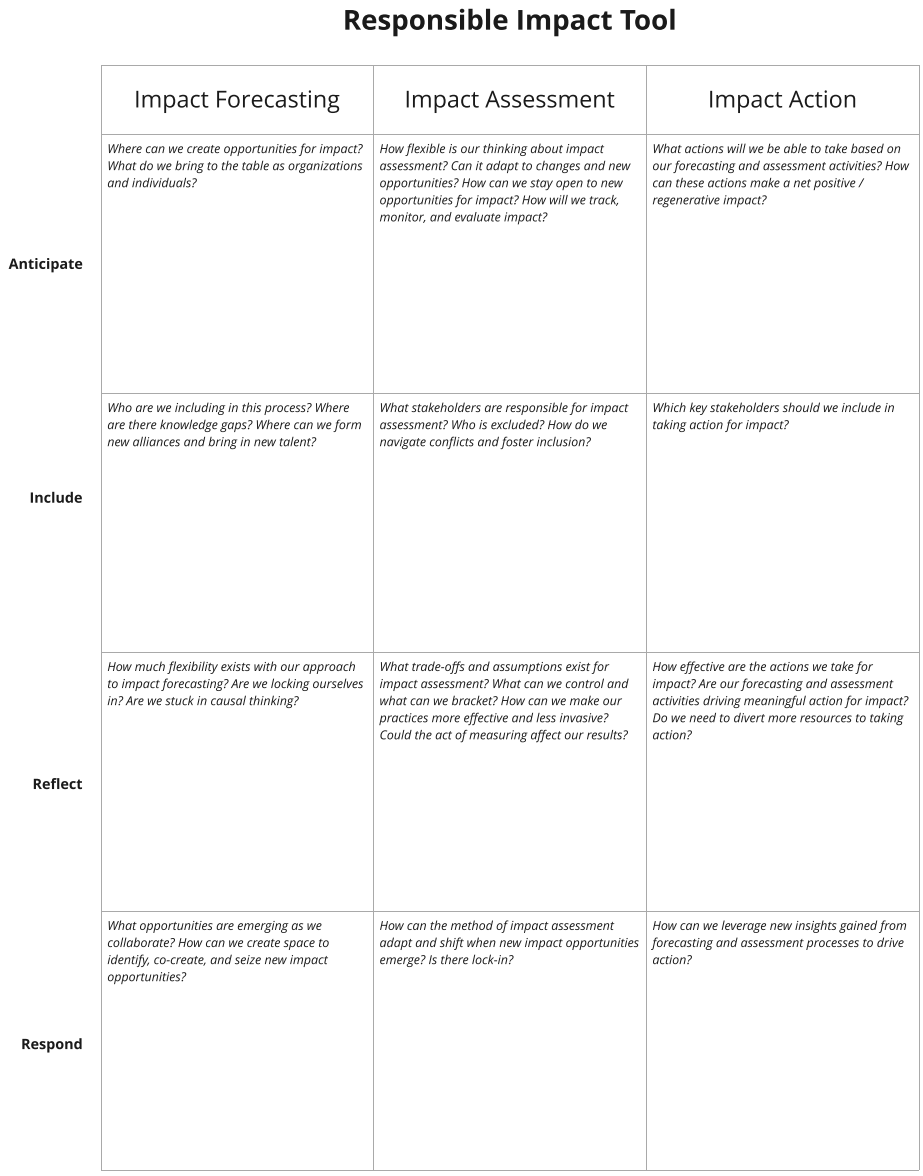

Fig. 3. Responsible Impact Tool. Workshop participants place sticky note responses in the appropriate squares.

4. Discussion and implications for impact forecasting and assessment

We now consider the implications of the RIL concept, its accompanying context for innovation, and the tools presented in Section 3.2 for thinking about sustainability-focused new ventures, impact forecasting, and impact assessment. We first examine the relationship between experimentation and effectuation, and how the RIL concept can help to reconcile the two. We then briefly consider how a RIL can facilitate an opportunity creation perspective in terms of sustainability impacts. Finally, we discuss the two tools and their implications for impact forecasting and assessment.

As mentioned in Section 3.1, the relationship between experimentation and effectuation is a point of contention in the effectuation literature, with Sarasvathy lamenting scholars' "equating effectuation to experimentation" and explicitly emphasizing that "effectuation is not experimentation" (Sarasvathy, 2021, p. 7). We would like to suggest that while effectuation and experimentation are in fact distinct conceptual processes that operationalize two very different logics, the RIL context can facilitate the alternating application of these two approaches in a synergistic, complementary way. By leveraging the tools in Section 3.2, actors can engage in effectuated innovation activities. As innovations emerge — be they organizational, technological, regulatory, or a combination of these — experiments can be devised and run to test the viability of these innovations in practice. At the same time, actors can retain an awareness of the context within which these innovations emerged — namely, the effectuation-influenced RIL — with the understanding that ongoing effectuated activity will allow for the creation of new opportunities, both for economic gain and sustainability impact. The RIL thus allows for a fluid back-and-forth movement across the liminal boundary which separates effectuation and experimentation, while reconciling the two in practical terms.

We also perceive the opportunity to connect broader discussions in the literature around experimentation as a key method of "environmental problem-solving" across a range of disciplines and actors, including "economists, policymakers and communities" (Ansell and Bartenberger, 2016, p.64), with the effectuated context of the RIL. Recent work by Sarasvathy (2021) on effectuation and the logic of effectuation provides an avenue for this in terms more familiar to firms and management researchers. This is particularly relevant in light of the need to co-create an economic future that centers around sustainable and responsible business models. Following Sarasvathy, traditional

approaches to scientific experimentation involve an "'as-if' logic," where the goal is theory building and hypothesis testing. Even if causal mechanisms are not entirely understood, it is still possible to build useful theory — theory which generates successful predictions — and to "continue to work with the theories we have, 'as-if' the assumptions they rest on are true" (Sarasvathy, 2021, p. 2–3).[6] By contrast, an effectuated, entrepreneurial approach to experimentation in the RIL context follows an 'even-if' logic: one which "seeks not merely to test hypotheses, but to co-create hypotheses worth reifying" (Sarasvathy, 2021, p.1). We see the combination of effectuation (the "entrepreneurial method") and experimentation (the scientific method) in the RIL context as essential for addressing sustainability challenges (Sarasvathy, 2021, p. 3; Sarasvathy and Venkataraman, 2011). Indeed, if one does not take normative ends for granted and opts to reject a business as usual approach to innovation — instead prioritizing responsibility and sustainability over a pure focus on financial returns — the effectuated logic of 'even-if' becomes exceedingly relevant. Applying a normative lens, effectuated experimentation can be formally expressed as "even if not-A, B is worth it" (Sarasvathy, 2021, p. 5). For Sarasvathy, the 'worth it' here is an "upside evaluative criteria other than probability of success," where 'success' is presumably understood in terms of profit (p. 5). We extend this by suggesting sustainability impact itself can be understood either as a form of success (in addition to or in place of financial return), or as an 'upside evaluative criteria'. Sarasvathy also acknowledges the relevance of even-if thinking for "sustainability challenges such as climate change," where "an even-if logic can be particularly useful in tackling wicked problems" (Sarasvathy, 2021, p. 6; Nelson and Lima, 2020; Sarasvathy and Ramesh, 2019). In the RIL, many such 'even if not-A, B is worth it' permutations exist, particularly in light of the moving target of impact forecasting and assessment. Even if opportunities for impact shift over time, it is worth moving forward with an innovation project, knowing that some sustainability impact can be made. Even if the future is uncertain, it is worth taking action, knowing that our actions themselves will help shape this future. Adopting an effectuated, 'even-if' logic can provide a powerful antidote to the otherwise potentially paralyzing effects of wicked problems such as climate change, characterized as they are by intractable uncertainties.

Further, adopting this logic can connect RIL effectuated experimentation with broader discussions around varieties of experimentalism and environmental problems (e.g. Ansell and Bartenberger, 2016). The RIL context serves to broaden a siloed or isolated view of entrepreneurial experimentation — one-off experiments which either succeed or fail, and which generate learnings with a limited scope of potential application — to what Ansell & Bartenberger term a Darwinian, systemic view of experimentation, where "trial-and-error learning" takes precedence (2016, p. 67). As a platform for experimentation where diverse stakeholders (firms, entrepreneurs, researchers, NGOs, policymakers, civil society, nature) are connected, the RIL connects individual experiments in a broader ecosystem of experimentation. While Sarasvarthy's aspiration of 'co-creating futures worth reifying' may appear unachievable if the level of analysis remains the individual experiment, it becomes more realistic when considered in terms of an emergent ecosystem of ongoing experiments, informing one another in line with effectuation processes as they 'increase variation' over time.

The RIL context also has implications for thinking about entrepreneurial opportunity. By endorsing the importance of opportunity creation and adopting an effectuated logic, RIL participants avoid conceptualizing sustainability impact or economic opportunity as fixed, extant objects awaiting discovery. Rather, both sustainability impacts and financial returns can be seen as dependent upon the effort and talent of the firms, entrepreneurs, researchers, and other actors participating in the lab: as opportunities which must be created. Strong opportunity creation ability (whether for impact or profit) thus becomes more central for a new venture's success than the ability to foresee and exploit unchanging opportunities which are simply 'out there in the world'. This has important implications for the nature of impact forecasting and assessment in such contexts: it underscores the importance of revisiting opportunities for impact and reevaluating methodologies of forecasting and assessment, making use of available means to co-create desirable ends, rather than taking ends as given and attempting to assemble the means to achieve them. It also bears significance outside the RIL context. A VC, business angel, or accelerator program explicitly aiming to invest in a venture with high impact potential might choose to fund an impact-focused startup not simply because a strong impact opportunity appears to exist, but because the team involved appears capable of making some significant impact in many possible future venture permutations.

Finally, we turn to an examination of the tools presented in Section 3.2. We suggest that before the process of impact forecasting and assessment can begin, we must first determine *what* impacts we want to assess, and *how* we want to assess them. The stakeholders involved in making this determination will heavily influence the methodology that is ultimately selected, emphasizing the importance of stakeholder inclusion in the process — something the 'inclusion' aspect of RRI underscores (Section 2.1). While firms are already "engaged in understanding the needs of the target beneficiary … and discussing with stakeholders how their innovation can be responsive to their needs," the literature lacks examples where innovation activities "critically examine which desirable implications are missed by the innovation, or whether it actually has negative implications" (Lubberink et al., 2017). The latter can be better facilitated in a RIL. Our own anecdotal experience in a RIL highlights the importance of including a broad suite of stakeholders when e.g. developing a venture-specific LCA methodology, as well as the value of taking a structured approach which leverages relevant tools in addition to more open discussions and roadmapping sessions with stakeholders.

Further, we argue that this process of asking 'how' and 'what' should itself be understood as effectuated, insofar as it ought to evolve and adapt to emergent circumstances and opportunities. In a business model innovation context, "emergent opportunities typically lack the deep wealth of data that are used to justify corporate actions," (Chesbrough, 2010, p. 361), thus emphasizing the precedence of effectuation, experimentation, and "adaptation ex post" over "superior foresight ex ante" (p. 356). A similar line of reasoning can be applied to impact forecasting and assessment of sustainability-focused business model or technological innovation: it makes little sense to develop impact forecasting and assessment methods which are grounded in causal logic — taking predetermined measures and targets for granted[7] — when these same methods aim to assess the impact of innovations which themselves are often effectuated. Instead, impact forecasting and assessment should remain fluid to avoid missing emergent impact opportunities. The tools developed in Section 3.2 are intended to facilitate this fluidity.

Further, the tools are intended to be a starting point for the RIL context — a launch pad rather than a destination. Given the experimental and reflexive nature of a RIL, we expect they will evolve over time. Conceptualized in design terms, the tools are what Berglund et al. (2020) refer to as "mutable" artifacts: they "have reasonably high interpretive flexibility in order to stimulate creative interactions among

[6] This is salient both in scientific fields as well as in certain types of applied business case testing, where the point of testing is to determine what works (e.g., is there consumer demand for X?), rather than to understand the cause behind what is working (e.g., why would consumers want something like X?).

[7] There are, of course, clear advantages to static, shared sustainability targets, as evinced by the development and subsequent widespread uptake of the SDGs at both the policy and firm level. At the same time, however, predetermined targets can contribute to greenwashing, allowing actors to simply tick the box of 'contributing to an SDG' without greater reflection on what tangible impacts are being made, and how those impacts may need to shift over time. See Lashitew (2021).

heterogenous stakeholders" (p. 831). The questions themselves are purposefully open-ended, as they are intended to encourage effectuated "transformation" via a "heterarchical form of organizing" — that is, within an evolving network of heterogenous stakeholders who continuously form new relationships, engage in new interactions, and cross organizational boundaries, all underpinned by "a shared sense of direction and a general interest in working together" (Berglund et al., 2020, p. 830; Hedlund, 1986; Sarasvathy and Dew, 2005).

This point is particularly important in underscoring the effectuated nature of the tools themselves. Consider by contrast other popular conceptual tools, such as the collection of experimentation-focused tools in Osterwalder et al. (2014) and Bland and Osterwalder (2020). These tools adopt a scientific, experimentalist logic, wherein assumptions around value propositions and business models ideas are subjected to rigorous testing. The tools follow the scientific method, laying out a hypothesis, describing testing processes, recording results, and deriving evidence-based insights. In contrast to the scientific method leveraged by this sort of tool, the Responsible Innovation Tool and Responsible Impact Tool follow Sarasvathy's entrepreneurial method: they aid practitioners not in running experiments, but in effectually co-creating possible futures in line with an 'even-if' logic. Practitioners using these tools engage in what Berglund et al. call "joint sensemaking," an activity which "requires artifacts that are sufficiently clear to enable meaningful communication among heterogenous actors," but which at the same time are "sufficiently incomplete, mutable, and question-begging to stimulate creative transformations" (p. 832; Venkataraman et al., 2012; Garud et al., 2008). This is of course a difficult balance to maintain, but one which we hope the tools presented here manage to achieve.

5. Conclusion and further research

We began with the research question: "How can the concepts of Responsible Research & Innovation (RRI) and effectuation inform firm-level sustainability-focused innovation activity as well as the forecasting and assessment of sustainability impacts for new ventures?" We have considered the challenges surrounding the forecasting and assessment of sustainability impacts related to innovation activity, particularly in new venture contexts. We suggested that the Responsible Innovation Lab (RIL), a type of living lab, can help guide innovation activities and facilitate forecasting and assessment by incorporating aspects of RRI into the non-linear, effectuated activity of sustainability-focused innovation. We have suggested that through the novel concept of a RIL, it is possible to combine insights from RRI and effectuation theory with firm-level and entrepreneurial activity in a sustainability-focused context. Further, drawing on RRI and effectuation theory, we developed two tools for guiding innovation activity in a RIL. These tools aim to ensure that economic/environmental trade-offs are considered, short-termism and technological solutionism are avoided, and effectuation processes are taken into account within broader value chain and innovation ecosystem contexts.

The challenges of forecasting sustainability outcomes and reducing uncertainty in new, innovative ventures and value chains often calls for co-creation of knowledge involving government agencies, industry, NGOs, and researchers. In the face of Grand Societal Challenges, individual firms and start-ups are increasingly forced to collaborate in broader innovation contexts to achieve desired sustainability impacts and implement necessary innovations: under these circumstances, a single firm or start-up will often struggle to 'go it alone' (George et al., 2016; Ferraro et al., 2015). We suggest that this sort of co-creation, open innovation, and knowledge sharing can occur in a RIL. The RRI concepts of anticipation, inclusion, reflexivity, and responsiveness along with the tools presented in this paper can be employed at different stages of an effectuated innovation process to move toward a shared understanding of sustainability issues and tradeoffs, as well as how different technological and regulatory choices can affect sustainability outcomes. Understood in these terms, impact forecasting and assessment is less about making predetermined decisions around the selection of particular methodological approaches and metrics. Instead, forecasting and assessment becomes an ongoing, reflexive process of re-evaluation, taking stock of shifting business models, technological trade-offs, regulatory developments, and sustainability targets. In this way, the process of developing and implementing a particular methodology for sustainability forecasting and assessment is itself an effectuated process, one which co-evolves alongside emergent innovation processes.

CRediT authorship contribution statement

Matthew Coffay: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Lars Coenen:** Conceptualization, Writing – review & editing. **Ragnar Tveterås:** Resources, Writing – original draft.

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.

Data availability

No data was used for the research described in the article.

Acknowledgments

This work was supported by the Research Council of Norway (SALMANSVAR, 'Responsible innovation in the Norwegian salmon farming industry: Grand Societal Challenges, Dilemmas and Improvements' [299404]; SusOffAqua, 'Unleashing the sustainable value creation potential of offshore ocean aquaculture' [328724]).

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Circular Economy and Sustainability (2023) 3:1361–1383
https://doi.org/10.1007/s43615-022-00239-w

ORIGINAL PAPER

The Circular Experimentation Workbench – a Lean and Effectual Process

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Received: 25 July 2022 / Accepted: 25 November 2022 / Published online: 7 December 2022

Abstract
Circular economy has become an important goal for companies to address climate change and pressing resource issues. Yet, the process of circular business experimentation is highly uncertain. While the lean startup has been applied to the circular experimentation process, the concept of effectuation has only been used to a limited extent, despite its potential. We investigate the following question: To what extent can lean startup and effectual thinking be combined to support the circular business model innovation process? We conducted 10 workshops where we combined these concepts with circular economy thinking. A novel process – the Circular Experimentation Workbench – was developed and evaluated to inspire participants to start experimenting with the circular economy. We found that lean startup and effectuation principles are highly complementary. Effectual questions can support the development of successful circular experiments. Our results were potentially limited by constraints related to the workshop format and action research method. Future research could build on the complementary perspectives of lean startup and effectuation to help accelerate the circular economy transition.

Keywords Circular business models · Circular economy · Sustainability · Effectuation · Lean startup · Business experimentation

Introduction

The circular economy is seen as an important avenue to combat global challenges such as climate change, resource scarcity, waste, and biodiversity issues. The promise is that the circular economy can create various win–win situations on an individual, business, and macro scale, such as the reduction of resource use, competitiveness, new revenues and cost reductions, and job creation [1, 2]. Circular economy should not be seen as a threat but rather as an opportunity as in particular younger consumers give increasing preference to

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sustainable products and circularity allows companies to make better use of existing products and resources [3, 4]. The resource-conserving strategies of a circular economy can be classified according to strategies for narrowing resource loops (i.e., using fewer resources per product), slowing resource loops (i.e., using products for longer), closing resource loops (i.e., recycling), and regenerating resources (i.e., using renewable resources and regenerating the natural environment) [5–7].

Scholars have noted the great interest of business and policy makers in circular economy [8] and new business models [9–11]. This is perhaps not surprising given the potential of sustainable and circular business models to generate significant sustainability impacts thanks to their holistic lens on how business is done and the incorporation of various stakeholders, including the natural society and environment, in the company purpose, vision, and performance indicators [12, 13]. Furthermore, in addition to the potential for substantial sustainability impacts, there is a growing awareness in conventional business circles of the financial upside and value-creation potential of circular and sustainable business models [4]. Examples of circular business models include IKEA's buyback and resell service designed to increase the lifetime of furniture and slow the loop, MUD Jeans' lease a jeans concept to close the loop, and Patagonia's regenerative organic agriculture model to regenerate the natural environment [14]. Furthermore, "gap-exploiters" pursue circular business models where the existing industry is lagging behind in pursuing circular business opportunities in sectors like ICT and electric vehicle batteries [15, 16]. In general, more radial circular business models, for instance, around slowing loops, have only been implemented to a limited extent in large businesses [17, 18]. At the same time, there are many circular startups [19], but it takes time before startups reach scale and scale impact, and there is a large failure rate.

This paper focuses on the business transition toward a circular economy, specifically by companies pursuing circular business models, and the role of tools and methods in it. Popular tools in business include the lean startup [20, 21], which takes an iterative approach of building, measuring, and learning about business models through experimentation based on hypotheses about the future business and testing ideas with customers early on. The lean startup was developed originally for startups [21] but is now widely used by large businesses [22], also in a sustainability context [23, 24]. Effectuation is an entrepreneurial approach based on leveraging the resources available [25]. Entrepreneurs leverage who they are (traits, abilities), what they know (expertise, experience), and whom they know (social and professional networks). Using these means, the entrepreneurs begin to imagine and implement possible effects that can be created with them [25]. In contrast to lean startups, effectuation has not been widely used in existing businesses. However, the effectuation focus on using "what is available" can be highly valuable in organizations that have to balance between continuing their existing business model which they are vested in and have allocated most resources to, with the new business model being tested.

This research seeks to understand to what extent notions from the lean startup and effectuation may be bridged to support businesses in their transition toward the circular economy. Furthermore, circular and sustainable business model tools' reviews have highlighted the need for tools supporting the process of experimenting and piloting, as well as transforming the organization for the circular economy [26, 27]. The following question is investigated: *To what extent can lean startup and effectual thinking be combined to support the circular business model innovation process?*

The next section describes the background of circular business model experimentation, effectuation and lean startup thinking, and the research focus in more detail. The "Method" section describes the action-oriented design science method to develop and test the novel

Circular Experimentation Workbench process. The "Discussion" section reflects on the complementarities and challenges when using lean startup and effectuation to support the circular business model experimentation process. Finally, the "Conclusions" section summarizes the contributions and next steps.

Background

This study seeks to bridge the research areas of circular business model experimentation, concepts on theories on effectuation and lean startup, and tools and methods. The following briefly reviews relevant literature to illuminate the research gap.

Circular Business Model Experimentation

Circular business models seek to create positive value for the environment, society, and customer [28], through strategies such as narrowing the loop (efficiencies, using less), closing the loop (recycling), slowing the loop (durability, product life extension), and regeneration (improving the natural and social environment) [5, 14, 29]. Sustainable and circular business models are important in the context of the circular economy because they have the potential to take a holistic view of the way business is done [12]. Circular business models are not only about the products but also in the way products and services get delivered to the customer so that the total environmental impact of these can be significantly reduced through efficiencies in production, use, and reuse phases [30]. In this way, companies might be able to achieve their ambitious circular economy goal more quickly.

Yet, circular business models do not emerge automatically and are only still emerging in practice [18, 31]. On the contrary, they need to compete with dominant existing linear business models, so significant experimentation is required to test the desirability, feasibility, viability, and sustainability of such new business models in practice [32]. For example, the case of experimentation with a circular business model in the fast-moving consumer goods industry, trialing a refill model, illuminated the need for convenience and accessibility as well as affordability, and a clear demonstration of the environmental improvement of such a model to the customer for successful adoption [33]. Experimentation is not only about the learning process but also about strategic legitimation, in particular in existing businesses [34]. Experimentation is becoming a more important theme in circular economy literature [27, 35].

Circular business model experimentation may be described as follows. It is *"an iterative approach to develop and test circular value propositions in a real-life context with customers and stakeholders, starting with a shared goal. It involves rapid learning based on empirical data to provide evidence on the viability of circular value propositions. Iterations involve increased complexity of experiments. There is a learning focus on initiating wider transitions, such as transforming consumer behaviours for the circular economy."* [36]

Companies are indeed experimenting with new circular business models in practice. Examples include rental, subscription, and lease to slow and close resource loops. Service-oriented business models can achieve a factor of 2 to 10 improvement in environmental impact reduction compared to just selling a product when the model is set up in the right way [37]. Companies are starting to launch several circular business models in different countries [38]. Experiments are necessary to understand first whether a business model is

desirable, feasible, viable, and sustainable [32]. Second, it allows companies to test to what extent the business model "works" or needs to be adapted in different contexts [38]. For example, the geographical landscape and infrastructure might determine the success of a bike-sharing model, or the regulatory environment might provide certain boundary conditions for a new circular business model that reuses materials [38].

The problems are that experimentation with circular business models is insufficiently happening routinely in practice. Moreover, only a small number of tools support the experimentation and piloting phase, as identified in a review by Pieroni et al. [27].

Effectuation and Lean Startup Type of Experimentation

Startups can be seen as one big experiment to test whether a business model works in practice [20, 21]. It is perhaps not surprising that tools such as lean startup, originating from startup literature, are being used by incumbent businesses and, notably, also large incumbents [22, 23].

Lean startup is an iterative approach to test hypotheses about a future business in a relatively short, time-bound, and cost-effective manner [21]. It contains iterative "build-measure-learn" cycles. A minimum viable product (MVP) is typically built as an experiment before committing too many resources to a full prototype [39]. One example is the "Wizard of Oz" simulation [39], where people manually, rather than technology, deliver the service provided. Think, for instance, about a new delivery system where all facets are still all operated manually to test whether people would use it before building it in full. These low-cost, low-resource characteristics also fit a corporate environment where most resources are allocated toward sustaining the existing business model and it is a challenge to gradually transform toward a more sustainable or circular business model [24, 40]. At the same time, recent scholarship highlights the need for lean startup methods to be adapted to work in incumbent contexts [41].

Perhaps surprisingly, another popular startup theory – effectuation – developed by Sarasvathy [25], is used less in the corporate sphere despite its potential. Sarasvathy developed the following principles for entrepreneurs: (1) bird-in-the-hand (use available means, make do with what you have), (2) affordable loss (what can I accept to lose), (3) crazy quilt (stakeholder commitments expand means and shape the enterprise), (4) lemonade (leverage uncertainty and exploit unexpected opportunities), and (5) the pilot-in-the-plane (actor agency shapes the future) [25]. These principles can support entrepreneurs in developing and shaping their ventures. However, principles such as focusing on using available means and the crazy quilt (working with familiar stakeholders) would fit a corporate context as both would reduce (search) cost. The lemonade and pilot-in-the-plane principles [25] might provide additional inspiration to help shape a new corporate context in an uncertain environment [42]. Some studies have investigated SMEs in relation to effectuation. Evald and Senderovitz [43] found effectuation to be useful for SMEs to be more innovative. Uzhegova and Torkkeli [44] found that effectual logic in SMEs can lead to more responsible business practices. More generally, Brettel et al. [45] find that effectuation is positively linked to success in highly innovative contexts, and Futterer et al. [46] found that effectuation can be most beneficial in a high-growth corporate context.

As contrasted with causal thinking (scientific approach of hypothesis testing fitting lean startup), effectuated approaches to innovation involve the leveraging of available means to create opportunities. Traditional causal approaches to innovation can be likened to preparing a meal with a recipe: The recipe is selected first, ingredients are

purchased, cooking implements are acquired, and a meal is prepared [25]. By contrast, effectuation implies seeing what is in the kitchen and improvising "one of many possible desirable meals" [25, p. 245]. In effectuation theory, entrepreneurs start with the following: (1) Who they are – their traits, tastes, and abilities; (2) What they know – their education, training, expertise, and experience; and (3) Whom they know – their social and professional networks. Using these means, the entrepreneurs begin to imagine and implement possible effects that can be created with them [25]. Effectual entrepreneurs transform market failures into sustainable solutions by self-selecting stakeholders [47].

Given the vast knowledge, technological, and capital resources available in incumbent firm environments — combined with what are often well-developed networks for collaboration — effectuated thinking promises to help firms leverage existing strengths and resources to develop new value propositions, innovate their business model, and actively shape and create market opportunity. Though this potential was recognized more than a decade ago, with Chesbrough [48], p. 362] suggesting companies "must adopt an effectual attitude toward business model experimentation," there is still a considerable practice gap. Some studies have investigated the benefits of effectual thinking, mainly by retrospectively analyzing R&D projects or ventures [45, 46]. However, few, if any, have analyzed such processes "in action." Exceptions include, e.g., the work by Keskin et al. [49], who followed new ventures over a longer period and found both effectual and causal processes to be at play, and Brown et al. [50], who used effectual notions in a workshop setting. Moreover, and importantly for the context explored here, scholars have not reached an agreement on whether (and if yes, how) these theories can be reconciled.

Critically, the inventor of effectual theory, Sarasvathy [51], has noted that scholars have reduced effectual action to the bird-in-hand principle without discussing either the crazy quilt (stakeholder self-selection) or the pilot-in-the-plane (co-creation) principles, or worse still, equating effectuation to experimentation. She emphasizes that "effectuation is not experimentation" [51, p. 7–8]. She argues that the scientific method of hypothesizing present in lean startup is helpful only with regard to predictable aspects of reality. As entrepreneurship deals with the unpredictable and the fundamentally unknowable, seeking to validate or falsify claims is not a useful strategy and definitely not the only or most suitable strategy available [51]. There are more fundamental differences: While lean startup type of causal reasoning focuses on expected returns, effectual reasoning emphasizes affordable loss [25]. Lean startup is about understanding fit compared to the competition, while effectual reasoning is built upon strategic partnerships; and while lean startup leverages pre-existing knowledge and prediction, effectual reasoning stresses the leveraging of contingencies [25].

According to Sarasvathy [52, p. 9], entrepreneurs often think effectually: "*They believe in a yet-to-be-made future that can substantially be shaped by human action; and they realize that to the extent that this human action can control the future, they need not expend energies trying to predict it*." Moreover, Sarasvathy [52] argues that rather than contemplating the extent to which the future is shaped by human action, it is not much use trying to predict it. Rather, it is much more useful to understand and collaborate with people who are engaged in the decisions and actions that influence the future (see, e.g., [13]). This is especially relevant in sustainability and circularity contexts, where the wicked nature of sustainability challenges implies considerable uncertainty [53]. Uncertainty in entrepreneurial contexts, however, can be overcome not by just gathering the correct information about the external environment but by participating in the process of gradually transforming it [54, 55].

However, businesses also need to understand where they fit against the competition and how they make an attractive offering by iterating their proposition, as done in the lean startup approach [21]. This potentially makes the combination of both approaches strong. Furthermore, there are many synergies between the approaches like the iterative approach, early stakeholder-involved learning, and low-resource approach of the method.

Table 1 highlights some of the differences and similarities between lean startup and effectuation.

Research Focus

Given the potential complementarities between effectuated and experimental approaches — combined with a lack of consensus in the literature regarding how the two can and should be reconciled — this paper offers a novel means of leveraging both logic by combining lean startup with effectuated thinking. Previous research has considered what tools or approaches might complement both effectuation and lean startup independently. For instance, Glen et al. [56, p. 662] propose design thinking as a "useful front end" process which can precede *either* lean startup *or* effectuated approaches to entrepreneurial action. Berglund et al. [54, p. 828] even juxtaposed experimentation and effectuation as distinct "ideal types."

Yet, to our knowledge, there has been no concerted attempt to combine the two, particularly in a sustainability context. Furthermore, both effectuation and lean startup methodologies have been critiqued for failing to facilitate actual ideation processes [56]. By combining these two methodologies together and conducting a series of workshops (as detailed below), we aim to provide counterevidence to this claim.

In addition to providing these insights, a workshop process for circular business model experimentation is developed. To date, several tools have been developed to support sustainable and circular business model experimentation [27], a tool being a generic name

Table 1 The lean startup vs. the effectual approach. (Source: building on [21, 25, 47, 51])

	Lean startup	Effectuation
Premises	Iterative build-measure-learn cycles	Start with available means: who you are, what you know, who you know
Focus	Expected return	Affordable loss
Competition vs. collaboration	Understanding competitive positioning	Forging strategic partnerships
Method	Scientific method	Entrepreneurial method
Approach	Scientific approach (as if) Knowledge and prediction Test hypotheses, e.g., A-B split testing "Value-neutral"	Effectual approach (even if) Leveraging contingencies Co-create hypotheses "worth reifying" Normative
Who to involve	Customer	Many stakeholders
View on the future	The future of a business can be predicted	The future can and should be shaped
Similarities	Quick customer/stakeholder-involved learning Low cost, time, or resource method	

for frameworks, models, concepts, or methods that codify knowledge and make it useful for researchers and practitioners to improve their decisions and actions [5, 57]. The business model canvas by Osterwalder and Pigneur [58] is a generic business model innovation tool used in other contexts [23]. Sustainability variants of the canvas have been developed such as the triple bottom line canvas by Joyce and Paquin [59], including the three layers of the triple bottom line (people, profit, planet), and the flourishing canvas by Upward and Jones [60]. Various workshop-based tools have been developed for sustainable business model innovation [32, 50]. Other tools include gamification [61]. According to a circular and sustainable business model review by Pieroni et al. [27], only 20% of the identified tools and methods were suited for the transforming stage of business model innovation, including activities such as experimenting, piloting, and implementing new business model concepts. Notably, at the time of initiating the first workshop (May 2016), few tools existed for circular business model innovation as the circular economy concept just started to gain popularity. The work by Pieroni et al. [27] shows that the earliest circular business model tools emerged from master theses (e.g., [62]), conferences (e.g., [63]), or from gray literature [64]. Pieroni et al. [27] point out that experimentation only started to emerge later as a theme recently (e.g., [65]).

Former research also suggested that few business and engineering tools for sustainability are effectively used in practice which is owed to the fact that those tools are not developed with the user in mind [66]. Hence, Bocken et al. [26] created a brief checklist for circular business tool development including various points such as the tool being circular economy specific, iteratively, and rigorously developed, and being used multiple times with the target group. This same research concluded that while a large number of tools for sustainable and circular business model innovation have been developed in the literature, only a small fraction of these satisfies three important design requirements: rigorous development (grounded in theory), validation from practice, and the presentation of a clear procedure for users. Hence, these points were taken into mind when developing a tool and process.

Method

This research uses an action-oriented design science method [32, 67, 68]. When adopting such a method, initial theories lead to a certain design solution (in this case, a workshop process tool) that is used and tested in practice (the workshop being run with innovators), and subsequent observations iteratively lead to an improved process or tool [67]. See Fig. 1.

We started with a practical need and objective to support companies in their transition toward a circular business. This was addressed by circular business model experiments that are seen as a pathway to transitioning toward a circular business, or as an important process in emerging startups [35, 69]. The goal was to develop a tool to help innovators and entrepreneurs design and develop experiments for circular business model innovation. The intended user groups include entrepreneurs, innovation or R&D managers, strategists and business model innovators, consultants, and designers who want to innovate business models for a circular economy.

The theoretical starting point was the use of lean startup and effectual logic to be used in a workshop setting. In the workshops, the authors aimed to inspire others (innovators in companies, entrepreneurs, researchers) to innovate and experiment with the

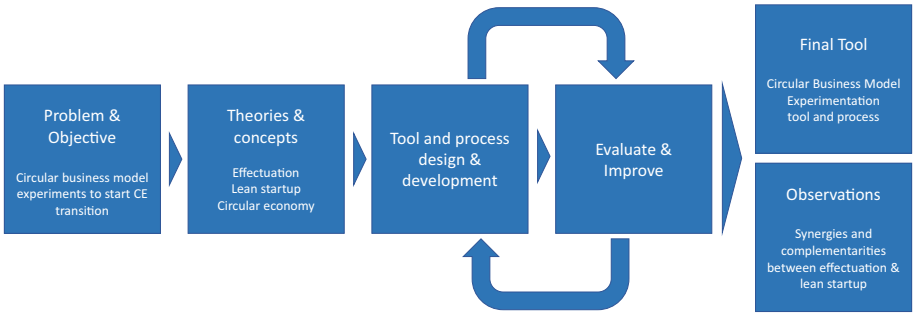

Fig. 1 Research process. Building on [67, 68]. CE refers to circular economy

circular economy. While no known circular business model innovation or experimentation processes existed in peer-reviewed literature when the workshops started, as the circular economy phase was only starting to emerge in a business context [8], the authors drew on the knowledge of existing innovation methods suitable for low resource and time settings. This was deemed suitable as most companies involved had little resources and time involved for such innovation but were interested in making a start and being inspired to innovate for the circular economy. Notions from lean startup and effectuation were both seen as highly relevant in this context as they are suitable in an entrepreneurial context.

As the tool seeks to spur users to consider circular economy, initially, several emerging circular economy examples from industry were used to enrich the discussion. A tool to support circular economy experiment inspiration was introduced in the final workshop process, the circularity deck by Konietzko et al. [5]. This tool gives inspiration on the circular strategies (narrow, slow, close, regenerate resource loops) that could be adopted by companies and is embedded in the final version of the process.

A total of 10 workshops were conducted, which combined lean startup, effectuation, and circular economy thinking. The period covers the period of 2016–2022 during which the authors developed and iteratively tested an approach to support circular business model innovation and experimentation. Table 2 includes an overview of how the tool incorporates elements of rigid tool development, such as testing the tool with the user group.

Table 3 provides an overview of the conducted workshops. Workshops 1–7 consisted of similar types of workshops where the process was iteratively improved based on the experience of using the tool in practice. The final tool was used in workshops 8–10. The main change in the final version of the tool was that both lean startup and effectuation principles were briefly explained at the start of these workshops. Furthermore, effectuation principles were added specifically to set the scene and refine experiments. While in other workshops, lean and effectual principles were already used, they became more prominent in the final workshop setting.

This final version of the workshop tool (Appendix 1) was used three times in a virtual workshop setting. For workshops 8–10 where the final tool was used, an evaluation form, using Google Forms, was used to assess the usefulness of the tool (see Appendix 2 for the main questions). This was supplemented by the experiences of the facilitators of the tool, as discussed after each workshop. Based on these, the authors developed propositions guiding future research in relation to effectuation and lean startup for circular business model innovation processes and specifically the development of experiments. See also Fig. 1.

Table 2 Tool criteria (criteria based on [26])

Tool criteria	How are these used in tool development
The tool is purpose-made	Focused on circular business model experimentation
The tool is rigorously developed—from literature and practice	Including effectual and lean startup logic, as well as circular economy literature, and tested in practice
The tool is iteratively developed and tested with potential users	Tested with the target audience
The final tool version has then been used multiple times by practitioners, and an evaluation of this process is done to assess tool use and usefulness	The final tool is tested 3 times and evaluated with a form and by the facilitators
The tool provides a transparent procedure and guidance	A structured, stepwise process used in the virtual tool
Circular economy or broader sustainability objectives and impact are firmly integrated	The circularity deck is used to incorporate circularity concerns
Simple and not too time-consuming	The final version is created so it can be completed in a 1.5-h virtual workshop
Inspires or triggers change	The goal of the tool is to inspire circular inspiration
Adaptable to different (business) contexts	Developed for both startups and existing business

The final workshop process ("Final Workshop Process") as well as the findings on the compatibility of effectuation and lean startup ("Evaluation of Final Workshop Process") are discussed next.

Results

In the "Results" section, we first discuss the development of the final workshop process ("Final Workshop Process"), followed by the quantitative and qualitative evaluation of the workshop ("Evaluation of Final Workshop Process").

Final Workshop Process

The workshop process was iteratively developed. In workshops 1–7, a similar process was used, building on lean startup principles as a starting point, but using some effectual prompts in addition. The main changes after these sessions were the addition of both an explicit (but brief) explanation of lean startup and effectuation principles and the inclusion of all effectuation principles. The workshop was also created for virtual participation on the online collaborative platform Miro. In this way, the workshop could be conducted with bigger groups virtually, and a larger audience of innovators could be reached.

The final workshop process that fits within a 1.5-h format was used three times with circular economy innovators (sessions 8–10 of Table 3). The final process looks as follows (see also Appendix 1 for the visual tool):

– Introduction in plenary form (10 min):

Table 3 Workshops conducted for this study

#	Workshop	Place and time	Lean startup elements	Effectual elements	Circular economy elements
Iterations					
1	Workshop with businesses of different sizes (~50 participants)	Finland, May 2016	Prompt about what lean startup is; hypothesis development, testing measures, and success criteria to create new circular business ideas, in a low-cost and iterative way	Prompts about who they are, what they know, what they have	Industry examples, prioritize according to impact (vs. feasibility), sustainable business model canvas
2	Workshop with PhD researchers in circular economy (~20 participants)	Denmark, November 2017	Prompt about what lean startup is; hypothesis development, testing measures, and success criteria to create new circular business ideas, in a low-cost and iterative way	Prompts about low cost and using available means and resources	Industry examples, prioritize according to impact (vs. feasibility, sustainable business model canvas
3	Workshop with PhD researchers in circular economy (~20 participants)	Denmark, November 2018	Prompt about what lean startup is; hypothesis development, testing measures, and success criteria to create new circular business ideas, in a low-cost and iterative way	Prompts about low cost and using available means and resources	Industry examples, prioritize according to impact (vs. feasibility), sustainable business model canvas
4	Workshop with 40 international business managers	UK, April 2019	Prompts about iteratively improving the value proposition; deliberate learning through value proposition iterations; low-cost testing	Working with stakeholders more effectively and efficiently to collaboratively address societal issues	Sustainable business model canvas, value mapping tool, sustainability idea cards; prioritize according to impact (vs. feasibility)
5	Workshop with ~25 European entrepreneurs	Sweden, October 2019	Prompts about iteratively improving the value proposition	Own perspective, ecosystems and stakeholder perspective, how to be the "pilot in the plane" (influence the ecosystem)	Circularity card deck with industry examples; conscious mapping of synergies between customer and circular economy proposition

Table 3 (continued)

#	Workshop	Place and time	Lean startup elements	Effectual elements	Circular economy elements
6	Workshop with 5 business participants of the same company *(sustainable scale-up)*	The Netherlands, December 2020	Hypothesis development, testing measures, and success criteria to create new circular business ideas, in a low-cost and iterative way	Questions: Who are you, and what is your role? What drives you? What data do they have as a starting point?	Industry examples; prioritize according to impact (vs. feasibility)
7	Workshop with 3 business participants of the same company *(sustainable scale-up)*	Virtual, June 2021	Hypothesis development, testing measures, and success criteria to create new circular business ideas, in a low-cost and iterative way	Prompts about low cost and using available means and resources	Industry examples; circularity card deck; ask to prioritize most impactful examples
Final tool					
8	Workshop with 18 business participants *(innovators in circular economy, globally)*	Virtual, February 2022	Explain the principles of lean startup. Hypothesis development, testing measures, and success criteria to create new circular business ideas, in a low-cost and iterative way	Explain principles of effectuation explicitly. Added: (1) Who they are and how they contribute to shaping the future; (2) What they can accept to lose, (3) Whom they know (4) What they can influence with whom (5)	Industry examples; circularity card deck
9	Workshop with 13 business participants *(innovators and consultants in circular economy, globally)*	Virtual, June 2022	Same as above	Same as above	Same as above
10	Workshop with 16 business participants *(innovators in circular economy, globally)*	Virtual, July 2022	Same as above	Same as above	Same as above

Table 4 Results from the evaluation

	Workshop 1	Workshop 2	Workshop 3	Overall assessment
How easy was the workshop to follow? *(mean and standard deviation)*	4.15 (0.69)	4 (0.63)	4.17 (0.49)	**4.11**
How useful was the workshop for you? *(mean and standard deviation)*	4.23 (0.83)	4.5 (0.84)	4.33 (0.53)	**4.35**
Number of respondents and participants	13 (18 participants)	6 (13 participants)	7 (16 participants)	

Here, the aim of inspiring participants to develop circular business model experiments is explained. The concepts of lean startup and effectuation are briefly explained.

– Three breakout sessions (in total 70 min):

Breakout session one (10 min) is about the innovators' starting point: What is their circularity challenge? For example, a company may be considering a shampoo refill station, or a clothing exchange platform, electric car leasing, etc. This is the first time that they join a virtual breakout group (food, mobility, etc.). Effectual questions are asked around what they find important (introspective part), how they want to shape the future (pilot in the plane) and what trends and uncertainties influence their business, and how negatives can be turned into positives (lemonade principle).

– Breakout session two is a "circularity brainstorm" to refine initial ideas (20 min). Prominent examples from the circularity card deck including strategies to close, slow, narrow, and regenerate loops [5] are used to get inspired to develop and refine ideas for circular business models
– Breakout session three is about experiment design (40 min). Innovators are asked to think about a hypothesis, test, and measures of success. They get inspired to form an initial experiment based on what they accept to lose (affordable loss), what and who they know (bird in hand and crazy quilt), how they can leverage uncertainty and unexpected opportunities (lemonade principle), and who they can influence (pilot in the plane). If there is time left, they can define measures and success criteria. Hence, effectual principles are used to inspire lean startup-type experiment design.
– Closure (10 min):

Any final reflections, sharing of the results, and feedback form.

Evaluation of Final Workshop Process

Workshops 8–10, where the final process was used, were evaluated using the same feedback form (Appendix 2). Participants were asked to evaluate how easy the workshop was to follow and how useful it was. Overall, the scores were very positive, where the workshop was seen as easy to follow (4.11 on average) and useful (4.35 on average), measured on a 5-point Likert scale where 1 is "not very" and 5 is "very much" (Table 4).

Table 5 Qualitative assessment

Key takeaways	Suggestions for improvement	Actions
Provided useful new methods (e.g., "the effectuation theory and experiment design," "clear frameworks." "circularity deck")	Explanation: - Additional intro or guidance - Written step-by-step process	- Allocate sufficient time for explanation - The final tool may include additional explanation text boxes to make it self-explanatory
Collaboration is fun and helpful ("co-creation is ultra great," "connection and group work," "always inspiring to hear other peoples stories")	Participants: - Do this with a multidisciplinary team - More people from the same sector	- Organize future sessions with specific teams within companies and/or take more time to select participants
Lean aspects were appreciated ("use less resources to implement a circular business model," "simplicity and rapidity to develop ideas," "quick inspiration")	Process: - More time/a little more time for the process - Series of workshops for the same team	- Extend the tool to a 2–2.5-h session when the setting allows for it - Incorporate the tool into long-term intrapreneurial innovation processes
Circularity aspects were helpful ("the circular deck," "circularity deck and tools," "circular deck and process")	Preparation: - Specific circularity challenges to prepare in advance	- When organizing sessions, pre-select challenges or ask companies to choose specific ones to deal with in the group

In addition, participants were asked for key takeaways and ways to improve the workshop. Table 5 contains the qualitative assessment based on the free text spaces filled in by participants. In general, the process lived up to its expectation of providing a starting point for quick iterative circular business model experimentation. However, there were some suggestions to improve the explanation, selection of participants, process, and preparation (Table 5). However, they did not change the main format of the tool.

Discussion

Previous circular economy studies have mapped existing tools and methods (e.g., [27]). Researchers have also noted the benefits of effectual thinking for the circular economy [70] or developed tools and methods that incorporated such thinking [50]. Others have investigated the value of lean startup for circular business experiments (e.g., [24]). This study makes two specific contributions: (1) the development of a workshop process that embeds the logic of both concepts and (2) a deeper understanding of the synergies and complementarities between both methods. In the following, we first discuss the contributions in more detail ("The Synergistic Use of Effectuation and Lean Startup"), followed by suggestions for future research and practice and the limitations ("Future Research and Practice").

The Synergistic Use of Effectuation and Lean Startup

This research found that the logic of lean startup and effectuation can be bridged successfully for the circular business model innovation process. In contrast to the argument about the incompatibility between more causal and effectual reasoning [51], we rather suggest that the more causal lean startup type of approach prominent in mainstream business (e.g., [22]) can be enriched by effectuation principles if used in the right way and vice versa. Former studies already stated the value of effectual reasoning for innovativeness [43] and lead to the development of more responsible business practices [44]. Vice versa, lean startup type of logic can support the development of (sustainable) business model innovations in established businesses, confirming earlier research by Bocken and Snihur [23] and Weissbrod and Bocken [24].

In the present study, we found that, first, the starting point of the workshop was helpful to understand how innovators can be impactful in the grand circular economy transition. We found that the effectual questions – what innovators find important, how they want to shape the future, what trends and uncertainties influence their business, and how negatives can be turned into positives – provided them with a focus on where they can be influential in the grand circular economy transition. In the workshops, broad ideas became much more focused.

This leads us to the following proposition:

Proposition 1 *Effectual questions about the innovators' starting point – what they find important, how they want to shape the future, what trends and uncertainties influence their business, and how negatives can be turned into positives – can help them focus on where they can specifically be influential in the grand circular economy transition.*

When developing actual experiments, many of the effectuation principles (e.g., lemonade principle, crazy quilt [25]) can provide practical guidance on how to set up practical, low-cost, and resource experiments prominent in lean startup [21]. We found that the effectual guidance helped innovators develop circular business model experiments more easily. Focusing on building on who and what is available and making the most of adverse situations is particularly useful in a volatile, uncertain, complex, and ambiguous (VUCA) world [42]. For instance, the COVID-19 pandemic forced businesses like restaurants to pivot their business models quickly [71]. Effectuation principles, like building on who and what is available, making the most of adverse situations, were found to provide useful input to circular business model experiment development.

Moreover, thinking about whom you share a circular challenge with or who could support your circular economy challenge can enrich circular business model experiments. Finding collaborators to join your challenge is also common in circular business practice [69]. For example, the Net-Works program is a collaboration between the Zoological Society of London, carpet manufacturer interface, and nylon manufacturer Aquafil, who together work on a solution to create new carpets out of (formerly) discarded fishing nets and avoid further disposal of fishing nets in the ocean [69]. We found that effectual logic can support the development of lean experiments also to solve circular economy challenges collaboratively. This was especially evident in workshops 8–10, where participants joined the workshop with overlapping interests and circularity challenges but often distinct networks, skill sets, and access to resources. The "crazy quilt" and "pilot-in-the-plane" aspects of effectuation thus became especially relevant, suggesting the importance of reaching outside one's existing organization and increasing multi-stakeholder collaboration when attempting to develop circular business models.

This leads us to the following proposition:

Proposition 2 *Using effectual logic, focused on building on who and what is available, making the most of difficult situations, as well as working with those stakeholders that can jointly exercise influence on the specific circular economy challenge, could support and enrich the lean logic needed for circular business model experiments.*

Conversely, the lean startup focuses on the customer and competitive positioning [20, 21], and the structure of cycles of experiments might add practical value to the effectual approach. In the workshop, the structured approach of ideas, hypotheses, tests, measures, and success criteria helped bring focus to the broader circular economy discussions. It helped innovators formulate more precise circular business model experiments for problems and challenges that started as broad wicked issues such as "plastic soup" and "textile waste." While thinking in effectuated terms can help entrepreneurs leverage contingencies and "co-create hypotheses worth reifying" [51, p. 1], it is through clarifying, testing, learning from, and iterating upon these hypotheses that new circular business models can emerge in practice.

Proposition 3 *Effectual entrepreneurs and innovators seeking to tackle wicked issues prominent in the circular economy transition might benefit from the structure provided by lean startup, as this practical guidance can help them to develop concrete circular business model experiments to start addressing these grand challenges.*

Future Research and Practice

The space in which businesses operate has become riskier, but also more volatile, uncertain, complex, and ambiguous [42]. The effects of a warming climate are already noticeable, biodiversity is in decline [72], and access to resources is an increasing business risk [73]. The circular economy is positioned as a paradigm to address not only urgent action to climate change [74], waste, and resource issues but also the criticality of raw materials and future competitiveness [75, 76]. Yet, existing companies typically still have a long way to go in their transition to a circular model, and while there are many emerging circular startups, many have failed to achieve scale [19, 38]. Hence, experimentation has become so important to trial new business models in practice and challenge dominant linear models [33].

First, in this research, we found that effectual logic can enrich lean startup type of experiment development. Effectual questions about what is important and how one can influence and shape the future ("pilot in the plane") under potentially adverse conditions ("lemonade principle") can help shape the innovators' focus within a circular economy. Furthermore, seeking out which stakeholders to experiment with ("crazy quilt") can help scale-up experiments more easily. While we did not test this explicitly, we suggest that the inclusion of stakeholders in innovation processes common in effectual logic can enrich the development of more systematic solutions needed for circular business model innovation. This confirms earlier research that suggests that early stakeholder involvement is needed for the sustainable and circular business model innovation process [12, 13, 50, 77].

Second, effectual entrepreneurs might benefit from the structure and customer focus that lean startup type of logic Blank [13] provides. The focus on testing early variations of business models with prospective customers as well as the positioning of the value proposition compared to the competition in lean startup provides a practical angle to enrich effectual logic.

Third, there are many synergies between the logic that can be leveraged. The combination of quick customer/stakeholder-involved learning and the low cost, time, or resource method of both effectuation and lean startup, combined with the explicit focus on stakeholder-involved problem solving common in effectual logic, can help inspire solutions to the wicked societal problems such as the circular economy transition. Table 6 compares both approaches and makes suggestions for synergies. The similarities and complementarities could provide useful starting points for future work.

Complementarities based on findings. Building on [21, 25, 47, 51]. An asterisk (*) denotes that this was an explicit finding from this study.

Future research may also focus on principles that were less prominent in this study, such as a broad interpretation of the effectuation principle of "affordable loss" [25]. Within the time and contextual constraints imposed by our test workshops, the principle of "affordable loss" received less focus and attention. In practitioner contexts, however, a more explicit focus on this principle as part of the circular experimentation process could add considerable value. First, as suggested by Coffay et al. [55], the traditional understanding of affordable loss can be extended to include not only just financial considerations (e.g., how much can we afford to lose if we invest in this idea?) but also environmental ones (e.g., where do we draw the line on emissions or nonrenewable resource consumption?). Furthermore, paying attention to affordable loss in effectuation terms helps to bridge the gap between sustainable and circular business model innovation

Table 6 The lean startup vs. the effectual approach

	Lean startup	Effectuation
Premises	Iterative build-measure-learn cycles	Start with available means: who you are, what you know, who you know
Focus	Expected return	Affordable loss
Competition vs. collaboration	Understanding competitive positioning	Forging strategic partnerships
Method	Scientific method	Entrepreneurial method
Approach	Scientific approach (as if) Knowledge and prediction Test hypotheses, e.g., A-B split testing "Value-neutral"	Effectual approach (even if) Leveraging contingencies Co-create hypotheses "worth verifying" Normative
Who to involve	Customer	Many stakeholders
View on the future	The future of a business can be predicted	The future can and should be shaped
Similarities	Quick customer/stakeholder-involved learning Low cost, time, or resource method	
Complementarities/synergies	Adds a structured approach to innovation* Focuses on competition and deeply understanding the customer Emphasizes early action and iteration	- Geared toward resolving wicked societal problems - Gives focus on what circular economy challenge to solve through effectual questions* - Supports identification of low-cost/resource experiments by emphasizing what/who is known and available* - Emphasizes inclusion of stakeholders that can influence the outcome in addition to customers*

practice on the one hand, and more "conventional" business model innovation (BMI) practice on the other, where building business model innovation funnels and portfolios imply a willingness to make limited investments in new ideas with the understanding that many of them will lead to short-term losses [78]. In much the same way that successful venture capital investment is predicated upon a large number of failed ventures and a small number of successful ones — with accompanying proportional losses and returns — success in business model innovation in corporate contexts typically requires the willingness to make rational "bets" on intrapreneurial projects, many of which will fail, but some of which will lead to new revenue streams. Operating with affordable loss (rather than a myopic focus on return on investment) as a starting principle is therefore important not just in "conventional" BMI contexts, but in circular and sustainable business model experimentation processes as well, where big wins take the form of both future revenue streams and substantial improvements in sustainability and circularity metrics.

Finally, the Circular Experimentation Workbench process ends with the development of specific experiments. In addition, the business model canvas [58] or lean canvas [21], or sustainability (e.g., [59, 60, 65] or a circular economy variety of the business model canvas (e.g., [77, 79]) could supplement the workshop. It could either be used as a follow-up or as part of the ideation phase to explore and map circular business models in more detail. Observation of workshop participants engaged in these aspects of the Circular Experimentation Workbench indicated that mapping the business model onto an extant canvas could contribute to a clearer conceptualization of the emergent business idea, as well as facilitate discussion between participants. It could also improve the ability of participants to extract implicit assumptions from the business model idea, thereby facilitating the formulation of testable hypotheses.

Limitations

This research also has some limitations related to the workshop format, action-oriented research, and the use of a virtual setting for research.

First, the use of workshop formats to simultaneously develop a tool and gather insight data is still rather new and untested. The sustainability tool development process is certainly not new and has been common for over two decades in design, engineering, and business studies [66]. Yet, the rigidity of tool development in research and practice is still insufficient, leading to many tools remaining unused in practice [26]. We have sought to overcome this limitation by rigorous development (grounded in theory), validation from practice, and the presentation of a clear procedure for users.

Second, while action-oriented research methods are gaining ground and are much needed in sustainability and circularity research to accelerate the transition, they might lead to role conflicts [80]. Being part of the action may have led to viewing the results more positively. Furthermore, experienced facilitators may also influence the outcomes [50, 81]. While the feedback on the overall process was positive (see Table 4), on average, 54% of workshop participants filled out the online survey. This could have influenced the outcome as not all participants gave written feedback. Ultimately, the sustainability transition might require a different role for academia in relation to business, with researchers engaging in more participatory forms of research and innovation — a transition that may already be on its way [80, 82]. Hence, it would be recommended to further develop action-based methods for the circular economy transition and develop appropriate evaluation methods.

Third, the final tool was only used in a virtual setting. While earlier versions of the tool were used with businesses in a face-to-face setting, it would be worthwhile to test the final version again with a face-to-face audience to better determine its value.

Conclusions

Given the urgency to address climate change and its negative impacts on biodiversity and people, as well as exacerbating waste and resource issues, it is becoming increasingly pressing to put the circular economy paradigm into practice. Circular business models such as second-hand offerings or rental platforms allowing for reuse and recycling provide a way to holistically address circular economy issues in a business context. It is important that established companies, who take up a large part of the innovation landscape, start experimenting with circular business models to challenge their dominant linear business models. To date, however, there are limited tools which companies can leverage for this type of experimentation.

In this paper, we build on lean startup, effectuation, and circular economy thinking to address this challenge. Lean startup and effectuation have been tried and tested in a startup context, but their value in a corporate or established business context is only starting to be explored (e.g., [24, 43, 44]. We investigated the following research question: To what extent can lean startup and effectual thinking be combined to support the circular business model innovation process? Using an action-oriented design science method, we conducted 10 workshops where we combined lean startup, effectuation, and circular economy thinking. This led to two key outcomes: (1) an evaluation of how lean startup and effectuation principles may be combined, and (2) a final tool, the Circular Experimentation Workbench.

First, this study contributes to research by a novel integration of lean startup, effectuation, and circular economy thinking by demonstrating its potential for combined usage in practice. It was found that lean startup and effectuation can be used in low resource and time settings. Effectual questions can support the focused development of experiments in the broad area of circular economy. Moreover, effectual logic – e.g., working with familiar stakeholders and making the most of what is available – can also enrich the lean logic needed for experimentation. Finally, while effectual entrepreneurs might seek to tackle wicked societal challenges, the lean startup can provide a structured approach to innovation.

Second, the novel Circular Experimentation Workbench was developed, so-called, as it integrates tools and approaches from different fields: lean startup [21], effectuation [25], and the circularity card deck [5]. By inspiring new circular experiments in different contexts, this tool was found to support the development of circular business models: innovators using the tool evaluated it as useful and easy to follow, commenting specifically on the usefulness of the process, principles, and circular economy inspiration.

As a contribution to practitioners, through this work, we aim to motivate those working in businesses to start experimenting with circular business models to challenge the still largely linear, unsustainable business models present omnipresent across industries [18, 83]. For policymakers, we see much value in the further development of the Circular Economy action plan as part of the European Green Deal. We encourage the nurturing of experimentation spaces for businesses and industries, and transdisciplinary partnerships. In addition, clear pathways are needed for business through sector-specific circular economy policies (necessitating repair, availability of spare parts, product longevity, etc.). The

creation of such pathways could pave the way for similar models and levels of adoption in other parts of the world [84].

Future research could build on the complementary perspectives of lean startup and effectuation to help accelerate the circular economy transition through not only encouraging experimentation but also scaling up initiatives. Methodologically, action-based methods can be useful to simultaneously advance research and practice for pressing issues such as the climate crisis.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s43615-022-00239-w.

Acknowledgements We would like to thank Jan Konietzko and Myrthe Velter for supporting the final workshops.

Author Contribution Conceptualization: Nancy Bocken, Matthew Coffay. Methodology: Nancy Bocken. Formal analysis and investigation: Nancy Bocken, Matthew Coffay. Writing – original draft preparation: Nancy Bocken, Matthew Coffay. Writing – review and editing: Nancy Bocken, Matthew Coffay. Funding acquisition: Nancy Bocken.

Funding Nancy Bocken has received funding from the European Union's Horizon 2020's European research Council (ERC) funding scheme under grant agreement No 850159, Project Circular X (www.circularx.eu).

Data Availability Data on specific workshop outcomes or individuals and their organizations are not available. The main outcome is the workshop process which is made available. The Circular Experimentation Workbench workshop template can be accessed freely here: https://miro.com/miroverse/circular-experimentation-workbench/.

Declarations

Ethics Approval and Consent to Participate The study was performed in accordance with the ethical standards of the research institution.

Consent for Publication Workshop participants and their organizations cannot be identified. However, informed consent was obtained from participants.

Competing Interests The authors declare no competing interests.

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Sustainable business model innovation, dynamic capabilities and organizational design: Insights from Norwegian aquaculture.

(Forthcoming). Business Strategy and the Environment.

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Abstract

Firms must increasingly grapple with complex sustainability challenges. Business model innovation is needed to achieve radical sustainability improvements. Recent research highlights the interrelatedness between business model innovation, dynamic capabilities, and organizational design, calling for empirical work to better illuminate these relationships. These connections are relevant in sustainability contexts, where organizational barriers and drivers have been shown to either facilitate or hinder the development of dynamic capabilities for sustainable business model innovation (SBMI). This paper presents a case study of an emergent low-carbon offshore aquaculture value chain in Norway to illuminate the importance and roles of these organizational factors. Based on our analysis, we identify those barriers and drivers present in the Norwegian salmon aquaculture industry, add to the body of theory around organizational design, dynamic capabilities, and SBMI, and offer insights for practitioners in the aquaculture sector aiming to develop dynamic capabilities for SBMI.

Keywords

sustainable business model innovation; dynamic capabilities; organizational design; aquaculture; organizational culture

1. Introduction

Faced with climate change, biodiversity loss, plastic pollutants, resource depletion, and other environmental externalities, governmental bodies are adopting increasingly stringent sustainability targets and reporting requirements for firms, embodied in e.g., the European Union's Corporate Sustainability Reporting Directive (EU, 2022) and Kunming-Montreal Global Biodiversity Framework (UNEP, 2022). Combined with growing consumer pressure and environmental risk, firms increasingly must transition to more sustainable forms of operation. While innovation at the business model level can help firms achieve significant improvements in environmental sustainability (Rashid et al., 2013; Stubbs & Cocklin, 2008), firms struggle to do this in practice (Evans et al., 2017: Ritala et al., 2018). The sustainable business model innovation (SBMI) literature refers to this as the 'design-implementation gap': firms often fail to successfully design and implement new, innovative, sustainable business models (Baldassarre et al., 2020; Geissdoerfer et al., 2018).

The food industry is a key sector with often unsustainable business models, including profound value chain inefficiencies and environmental issues (Bocken & Short, 2021). Intensive land-based animal agriculture is particularly problematic in terms of greenhouse

gas emissions. Aquaculture has potential to produce protein at a fraction of these land-based emissions (Coffay & Tveterås, 2023). In Norway, salmon aquaculture has grown from a nascent industry in the 1970's to one of the country's largest (Fløysand & Jakobsen, 2017). Norway is the world's largest producer of farmed Atlantic salmon accounting for just over half the globe's production (Pandey et al., 2023). Norway also leads the globe in terms of its sophisticated innovation system, value chain, and research institutions for salmon aquaculture, with annual industry revenue exceeding 50 billion USD (Allied Market Research, 2021; Intrafish, 2022; Bergesen & Tveterås, 2019). However, the industry faces significant biological and environmental bottlenecks to growth, including salmon escapees, emissions, and disease, with mounting pressure from public stakeholders to address these issues (Osmundsen et al., 2017). Managing and governing salmon aquaculture has been characterized as a 'wicked problem' due to uncertainty, shifting challenges, lack of consensus, and persistent problems without clear solutions (Osmundsen et al., 2017; Rittel & Webber, 1973).

Innovation for sustainability in salmon aquaculture has traditionally focused on improving efficiencies through developing new technologies, with little attention paid to business model innovation. However, seafood markets have become increasingly globalized with salmon as a leading species (Pandey et al., 2023). With a rapidly growing global industry and increasing company sizes, innovation is needed to remain competitive and to do so sustainably (Pandey et al., 2023). SBMI could account for stakeholders' concerns (Bocken et al., 2014; Evans et al., 2017), and the 'wicked problem' of overcoming the industry's environmental challenges (Minatogawa et al., 2022). To overcome limitations on growth, firms are evaluating moving production from sheltered 'inshore' areas (where production now occurs) to exposed 'offshore' areas at sea. Such a move will challenge not only existing technologies and value chain infrastructure, but also traditional business models which have evolved to exploit inshore production.

Success with transitioning to environmentally sustainable offshore production will in part mean succeeding with SBMI and overcoming the design-implementation gap (Geissdoerfer et al., 2018). Recent research underscores the importance of a firm's organizational design for developing adequate dynamic capabilities — a firm's ability to sense, shape, and seize new opportunities while continually transforming the organization and business model (Teece, 1997) — which in turn enable conventional business model innovation (Teece, 2018; Fjeldstad & Snow, 2018) and SBMI (Bocken & Geradts, 2020; Inigo et al., 2017). Much of this research is emergent, calling for empirical studies to deploy and test these theories (Inigo et al., 2017; Bocken & Geradts, 2020). Dynamic capabilities provide a useful means of describing and understanding how firms actually engage in and sometimes struggle or fail in SBMI (Bocken & Konietzko, 2022). As the world becomes more volatile, uncertain, complex, and ambiguous (VUCA), business model innovation is increasingly seen as essential for long-term business success (Schoemaker et al., 2018). Organizational design for dynamic capabilities and SBMI has been explored in terms of institutional, strategic, and operational barriers and drivers (Bocken & Geradts, 2020). However, this research has only focused on a handful of multinational corporations (MNCs), and there is a need for a better understanding of how organizational barriers and drivers can manifest in other industry and firm contexts, as well as how these issues can be addressed to succeed with SBMI.

We address these research gaps via a case study of an emergent low-carbon offshore aquaculture value chain in Norway. We address the following research question:

RQ: How do organizational design, dynamic capabilities, and sustainable business model innovation interact in the context of an emergent low-carbon offshore aquaculture value chain which places new organizational and capability demands on firms?

The paper is divided into six sections. Section 2 offers theoretical background in SBMI, organizational design, and dynamic capabilities, the aquaculture sector and research gap. Section 3 discusses the case background and details our methodological approach. Section 4 presents the results, while Section 5 discusses their implications and the limitations of the research. Section 6 provides a conclusion.

2. Background and research gap

2.1. Sustainable business model innovation

The business model literature has boomed in the last decades, with popular conceptualizations including the business model canvas (Osterwalder & Pigneur, 2010), business models as activity-based systems (Zott & Amit, 2010), processes (Zott & Amit, 2015), or emerging conceptualizations according to value propositions, creation, delivery and capture (Bocken et al., 2014; Richardson, 2008; Massa et al., 2017). According to Massa et al. (2017), this "diversity of definitions" reflects varying "subject-matter lenses" which researchers have applied to studying business models (p. 76). Geissdoerfer et al. (2018) define business models as "simplified representations of the value proposition, value creation and delivery, and value capture elements and the interactions between these elements within an organisational unit," and business model innovation as "the conceptualisation and implementation of new business models" (p. 405).

Ontologically, business model innovation is often understood in terms of the business model canvas (Osterwalder and Pigneur, 2010), a tool for conceptualizing business model innovation in terms of changes to the canvas' nine components. These include the Value Proposition,; supply-side considerations (Key Activities, Key Partners, and Key Resources); demand-side considerations (Customer Segments, Customer Relationships, and Channels), and Revenue Streams and Cost Structure. We adopt this approach to conceptualizing business models.

Recently, there has been a growth in research interest around sustainable business model innovation (SBMI) (Evans et al., 2017). Earlier work started with defining a business model for sustainability (Stubbs & Cocklin, 2008) and the types of innovations (Boons & Lüdeke-Freund, 2013; Bocken et al., 2014). Building on this work, SBMI is about bringing environmental and social concerns to bear on business (Foss & Saebi, 2017; Massa et al., 2017). SBMI is therefore understood as "innovation to create significant positive impacts, or reduce negative impacts, for the environment and society, through changes in the way the organization and its value-network create, deliver and capture value or change their value propositions" (Bocken et al., 2014, p. 44). Amongst other things, SBMI is distinct from business model innovation in that it implies "proactive multi-stakeholder management" and a "long-term perspective" (Geissdoerfer et al., 2018, p. 407). This extends the existing

acknowledgment that business model innovation occurs in a value network (Zott et al., 2011), and the focus in the open innovation literature on collaboration among actors who rely on each other's capabilities for value creation and capture (Chesbrough et al., 2018). The latter connects value creation and capture (business model thinking) with 'ordinary' capabilities, while the research presented here further links business model innovation with dynamic capabilities.

2.2. Dynamic capabilities

The dynamic capabilities approach emerged in the late 1990's as an alternative to conventional forms of explaining firm competitive advantage (Ambrosini & Bowman, 2009), particularly the resource-based view of the firm (Penrose, 1959) which posits that competitive advantage rests on the firm's difficult-to-imitate resources (Teece et al., 1997). By the late 1990's, the resource-based approach was no longer delivering competitive advantage in emergent high-tech markets. Teece et al. (1997) noted that despite companies such as IBM and Philips aggressively accumulating technology assets, they were losing competitive advantage to those which could "demonstrate responsiveness and rapid and flexible innovation alongside management's ability to coordinate and redeploy competencies. Accumulating technological resources did not necessarily lead to the development of these 'dynamic capabilities'.

According to the dynamic capabilities view, firms are understood as having ordinary and dynamic capabilities. Ordinary capabilities are the routines which allow a firm to conduct its day to day business and exploit its existing business model(s) (Teece, 2018). By contrast, dynamic capabilities include "the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets" (Teece, 2007, p. 1319). More recently, Teece (2018) further disaggregates dynamic capabilities into "second-order" microfoundations, including adjusting, reconfiguring, and developing new ordinary capabilities, as well as the "higher order" types described above (sensing, seizing, and transforming), including notably "[devising] new business models to seize new or changed opportunities" (p. 40-41).

Given our focus here on SBMI, we consider these 'higher order' dynamic capabilities in lieu of a focus on the microfoundations. Sustainable innovation at the microfoundation level often takes the form of incremental improvements in sustainability (e.g., efficiency improvements) rather than more radical transformation. By contrast, we focus on how firms can take action on higher order dynamic capabilities to sense new sustainability opportunities, seize these opportunities through innovation, and transform as an organization.

2.3. Organizational design, dynamic capabilities and SBMI

Despite the importance of dynamic capabilities to drive SBMI, this field is relatively new (Inigo et al., 2017). Amui et al. (2017) note a lack of literature connecting dynamic capabilities with corporate sustainability in general. Recently, research has begun to consider potential linkages between organizational design, dynamic capabilities, and (sustainable) business model innovation (Leih et al., 2015; Teece, 2018; Fjeldstad & Snow, 2018; Bocken & Geradts, 2020). Organizational design can include elements such as

strategy, people, structure, and management processes and the values, beliefs, and assumptions that guide leadership and decision-making (Bocken & Geradts, 2020; Burton et al., 2006; Galbraith, 1974; Miles & Snow, 1978; Miles & Creed, 1995).

While Fjeldstad and Snow (2018) consider connections between organizational design and business model innovation, Leih et al. (2015) link organizational design and business model innovation with dynamic capabilities, noting that an organization's structure, incentives, and culture may be more or less well suited to explore new opportunities. Teece (2018) further considers the connections between these concepts in terms of both incentive structures as well as the implementation of shallow management hierarchies and decentralized structures to foster rapid innovation.

While Bocken and Geradts (2020) include strategy in their definition of organizational design (alongside institutional factors and operations), Teece (2018) considers strategy in terms of its relationship to business models and dynamic capabilities but does not address whether it is an element of organizational design. Unlike Chesbrough & Rosenbloom (2002) who consider strategy as integral to a business model, Teece sees strategy as related but distinct from designing business models (Teece, 2018; Teece, 2010). Teece (2018) further includes the 'realigning of culture' (an important aspect of organizational design) as *constitutive* of transformation-type dynamic capabilities.

Building on Teece (2018), Bocken and Geradts (2020) further develop the relationship between organizational design, dynamic capabilities, and SBMI. By conducting a cross-industry case study of some of the world's largest companies, Bocken and Geradts (2020) concluded that specific organizational barriers and drivers at the institutional, strategic, and operational levels can hinder or support the development of dynamic capabilities for SBMI (Figure 1). This classification of barriers and drivers further underscores Bocken and Geradts' (2020) incorporation of strategy into a definition of organizational design. While Bocken and Geradts (2020) define 'institutional' as the "well-established rules, norms, and beliefs that describe the reality for the organization and guide their actions accordingly" (Bocken & Geradts, 2020, p. 6), we interpret these 'institutional' organizational elements as 'cultural', where organizational culture is understood as the norms influencing and guiding organizational behavior (Teece, 1996; O'Reilly, 1989; Fiol, 1991). This renders our results more actionable for managers (by removing jargon) and allows us to combine insights from Bocken and Geradts (2020) with Teece (2018), Teece (2023), and Leih et al. (2015), which discuss firm-level 'cultural' considerations. Teece (2023) in particular notes the importance of organizational design and culture for developing dynamic capabilities, arguing that dynamic capabilities eventually become "partially embedded" in organizational culture (Teece, 2023, p. 119).

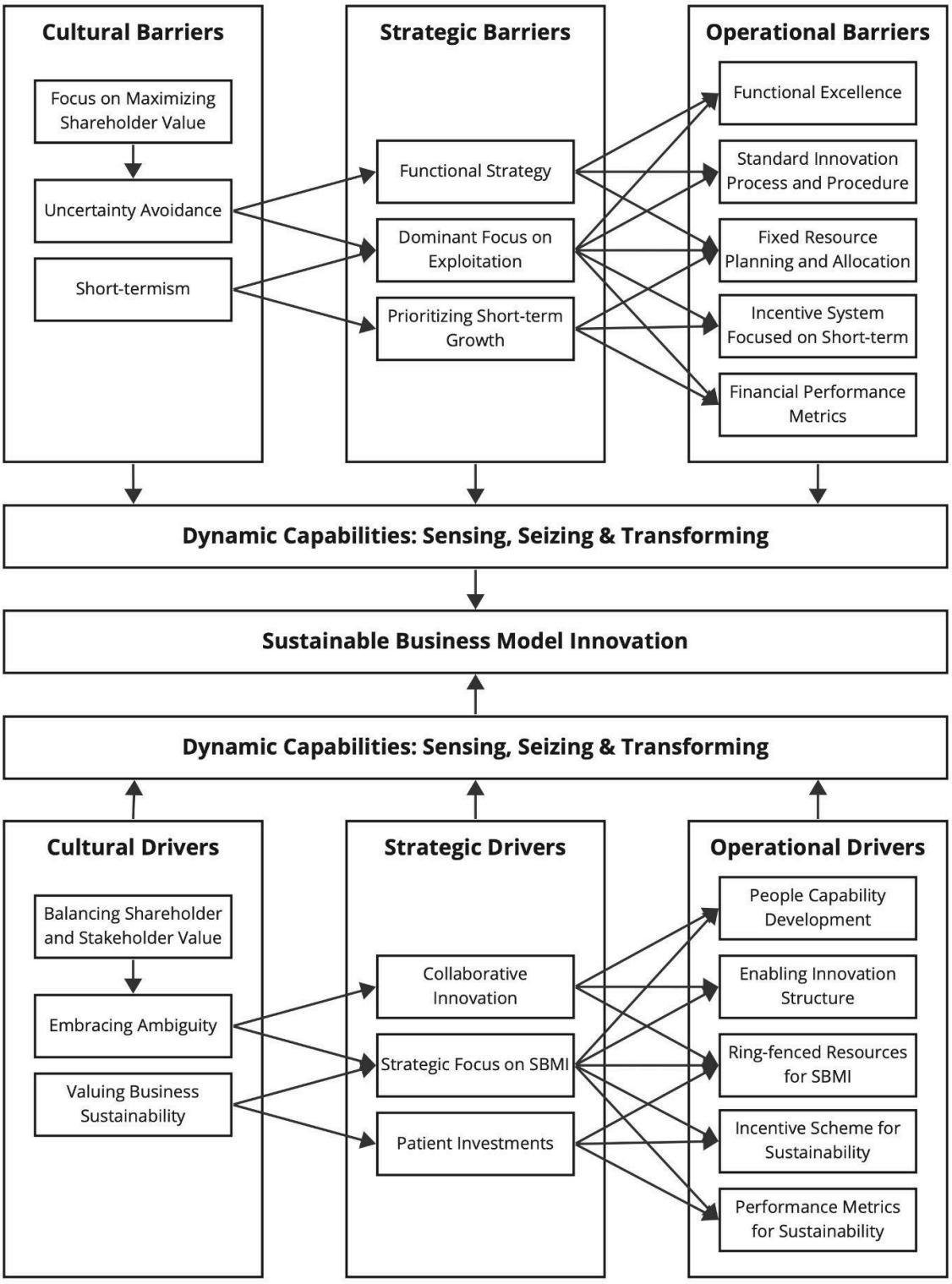

Figure 1. Identifying barriers and drivers for SBMI. Adapted from Bocken & Geradts (2020)

There have recently been calls for research exploring the connections between organizational design, dynamic capabilities, and (sustainable) business model innovation, including how specific organizational barriers and drivers present in particular industry

contexts (Teece, 2018; Bocken & Geradts, 2020). Such research could illuminate the importance of specific organizational factors in these contexts and enhance our understanding of how organizational barriers and drivers help or hinder SBMI.

2.4. Aquaculture and sustainable business model innovation

Aquaculture is farming in freshwater and seawater, where finfish and other species are reared in ponds or cages and fed tailored feeds. Fishing typically takes place through open-net pens, which allow for free exchanges between the farm and the surrounding environment, so environmental assessments are typically done before farming is permitted (Pandey et al., 2023). Global aquaculture has long faced pressure to improve its sustainability (Naylor et al, 2021). Salmon aquaculture is the most industrialized aquaculture sector, approaching biological manufacturing and is generally perceived as technologically leading, with highly specialized suppliers and increasing levels of digitalization (Tveterås, 2002; Moe Føre et al, 2022; Afewerki et al, 2022).

Some research explores aquaculture and industrial symbiosis, where individual businesses undertake “a collective approach to competitive advantage” which includes “physical exchange of materials, energy, water, and by-products” (Chertow, 2000, p. 314; quoted in Neves et al., 2020). Martin and Harris (2018) examine an industrial symbiosis network in Sweden, with salmon aquaculture playing an important role. Neves et al. (2020) cite numerous examples of aquaculture in industrial symbiosis projects in Denmark, Sweden, and China. More broadly, industrial symbiosis has been linked to business model innovation (Short et al., 2014).

There is a lack of research on SBMI in salmon aquaculture, although it is a rapidly growing industry, also in terms of company sizes and potential impact on the environment (Pandey et al., 2023). Moving production from inshore to offshore as an avenue for sustainable growth in the industry (Moe Føre et al., 2022) is not a pure technical problem, but also a challenge to firms’ traditional business models which were developed to maximize efficiency and profitability as part of an inshore value chain. These firms are lean organizations with operational focus on exploitation of highly refined conventional business models. Winter (2003) argues that firms need not develop dynamic capabilities to adapt to change, and that “ad hoc problem solving” can sometimes overcome threats to existing business models (p. 992). However, the development of dynamic capabilities for sensing, seizing, and transforming in the VUCA environment of salmon aquaculture are clearly preferable to ad hoc adaptation. This is so, considering firms’ leanness, the complexity of shifting externalities, the emergence of unforeseen challenges as firms move offshore, the number of stakeholders involved in the development of an offshore value chain — including policymakers and government regulatory agencies which must propose, assess, and approve new production sites — and the increasingly VUCA nature of business in general (Schoemaker et al, 2018). Our research also holds relevance for other primary industries, where regulatory frameworks, interaction with policymakers, and addressing environmental concerns are increasingly important for securing the social license needed for production, and where the same VUCA context presents challenges to innovating on conventional business models.

3. Method and case background

In this section, we first discuss the case context, followed by the case study approach which incorporates aspects of action research.

3.1. Case context and background: Low-emission offshore aquaculture value chain

3.1.1. Context

The salmon aquaculture value chain has several stages (Figure 2). Some of the largest companies — including two in the case study (Salmar and Grieg Seafood) — are vertically integrated from onshore production of fingerlings (smolts) via sea-based grow-out farming to processing, international marketing and distribution.

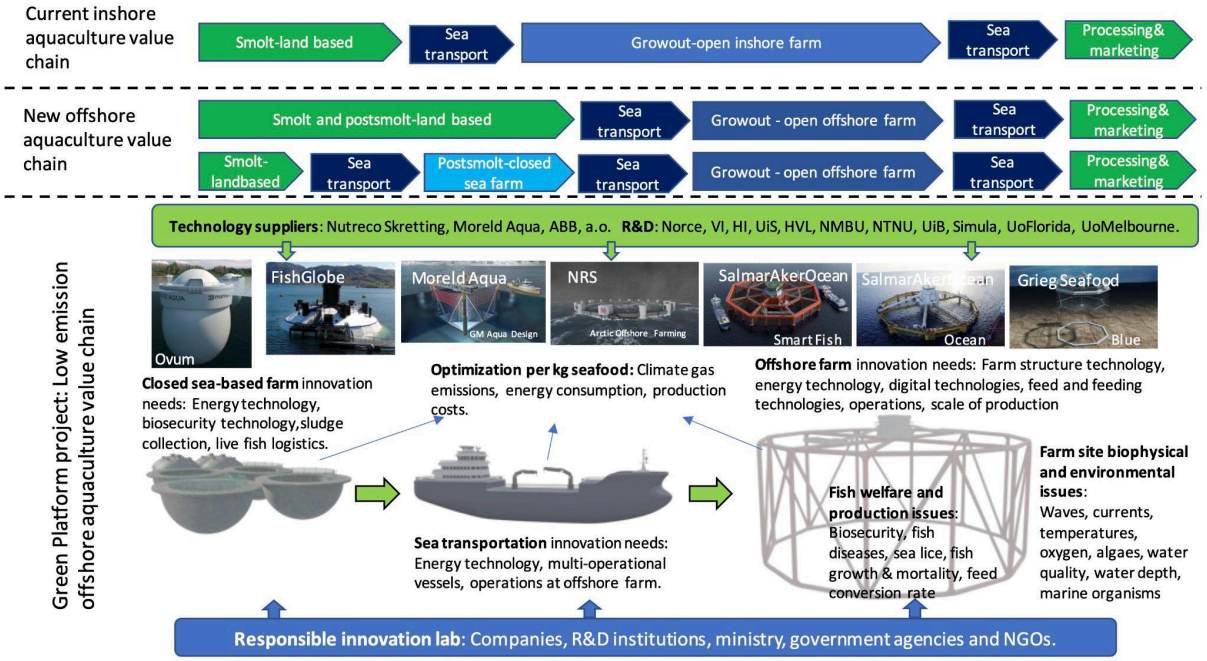

Figure 2. Aquaculture value chain and Green Platform project.

Conventional business models center around production of salmon from egg to harvestable salmon. Marketing is B2B, with international processors and retail chains as main buyers. The value proposition involves provision of large, reliable volumes of a healthy, nutritious and safe protein primarily in the form of a fresh, slaughtered salmon which satisfies customers' need for planning, efficient capacity utilization and marketing to consumers (Kvaløy and Tveterås, 2008; Cojocaru et al., 2021).

Farmed salmon generally has a lower carbon footprint than other meat proteins, with CO_2 equivalent emission per kg of edible protein typically around 20% that of beef, 50% that of pork, and comparable to poultry (Poore and Nemecek, 2018; MacLeod, 2020; Winther et al,

2020). However, the industry faces significant biological and environmental bottlenecks to sustainable growth (Osmundsen et al., 2017) related to diseases, parasites (sea lice), salmon escapees, biological emissions, and climate and biodiversity footprints from use of scarce feed ingredients sourced from both marine and terrestrial environments. Mortality is high in large parts of the industry due to diseases and other biological problems (Naylor et al., 2023). The industry growth rate has subsequently declined in recent years (Afewerki et al., 2022). Combined with mounting pressure from a range of stakeholders (government, consumers, and society at large) to address sustainability issues, the salmon industry must grapple with sustainability considerations to a larger extent than e.g., terrestrial protein production (Misund et al., 2023; Naylor et al., 2023).

Until now salmon aquaculture has only occurred in sheltered inshore waters, e.g., fjords. Increased inshore production has led to increased environmental externalities, and in some regions further growth has become unsustainable in the short run. 'Offshore aquaculture' in more exposed waters (often defined by significant wave heights above 4 meters, as opposed to the relatively calm inshore conditions) has recently received attention as an avenue for sustainable growth (Moe Føre et al., 2022).

Offshore ocean areas representing around 70% of the earth's surface provide opportunities for reducing environmental externalities substantially while dramatically increasing total output. However, compared to conventional inshore locations, offshore aquaculture faces extreme wind and wave conditions, long distances from shore to farms, and significant biological and technological challenges (Figure 2). To become economically and environmentally sustainable, offshore aquaculture requires an entirely new value chain and multi-billion USD investments to achieve sufficient economies of scale (Moe Føre et al., 2022).

3.1.2. Case study: Green Platform: Low emission offshore aquaculture value chain

In our case study, we draw on interviews, participant observation, and published data (white papers, annual reports, etc.) from a number of companies involved in the development of a new offshore aquaculture value chain (Figure 2). Our case context is a large research and innovation project, "Green Platform: Low emission offshore aquaculture value chain," co-funded by the government and case companies. Seven companies and ten research institutions are partners in the project.

The project aims to reduce climate emissions by developing new knowledge and technological solutions in key areas (Figure 2), facilitated through collaboration between leading research institutions and firms representing all stages of the value chain. This demands innovation on the part of all participating firms. A central premise of the project is that reducing emissions depends on recognition of interdependencies between different stages of the value chain, and between biological, technological and organizational processes. R&D activities in the work packages include electrification of farming systems and vessels, innovations for improved fish health and welfare, digitalization and automation to reduce labor and improve operations, and feed and technology innovation to reduce feed spill. Each of the seven subprojects in the Green Platform project involves multiple partners, typically both private companies and research institutions. The project has a steering group with members from each of the seven companies and the leading research institution.

3.2. Method

We take a case study approach (Yin, 2013) with elements of action research (McManners, 2015), incorporating semi-structured interviews and substantial content analysis. The action research case approach “combines the focus on inquiry and action offered by action research with the case study methodology described by Yin (2013)” (Bocken et al., 2017, p. 10). It allows researchers to go beyond the role of neutral observer to a participatory role whilst retaining academic rigor (McManners, 2016), and is seen as instrumental in the transition to a sustainable world (McManners, 2015; Bocken et al., 2017). We followed Yin (2013) in selecting this case for a single case study, as it is unique and offers unusual revelatory potential. Two of the authors participated in the innovation project (Section 3.1.2), giving them unique insight into innovation processes as they unfolded and facilitating an action based (as opposed to a passive ex-post analytic) approach.

The management literature has recently highlighted the relevance of inductive methods for addressing Grand Societal Challenges (Eisenhardt et al., 2016), with industry carbon emissions and the resulting climate change constituting such a challenge (George et al., 2016). Ferraro et al. (2015) characterize Grand Societal Challenges as complex, uncertain, and evaluative, driving firms to engage in collaboration where inductive methods can handle complexity and provide insight. We follow recommendations from Eisenhardt et al. (2016) for ensuring qualitative rigor, focusing on strong and coherent theoretical grounding and grounding our work in data, aiming to develop “rich and unexpected insights” (p. 1121).

We further enhanced rigor and theory-building potential by following the theory-building approach Gioia et al. (2013) and Locke (2001). Interview questions were open-ended while still addressing the research question, and were refined throughout the process. We followed a grounded approach to theory building. The first author stayed close to the data, while the second author maintained distance and offered feedback on emergent codes and themes. While we describe the process below in a linear way, the process itself was iterative and reflexive, moving back and forth between codes, concepts, and themes (Gioia et al., 2013).

Data included semi-structured interviews, participant observation, and document analysis. A round of 7 interviews was carried out between March-July 2022 with representatives from firms involved in the Green Platform project (Table 1). Participant observation began much earlier (spring 2020), leading to more substantial participant observation prior to and following the project kickoff (January 2022). This included more than 50 meetings with the project steering group, individuals, and small groups of stakeholders (Table 2). These meetings helped plan and coordinate the project while providing context for case study planning and outcomes. Written notes were taken during meetings, and the first and second author routinely discussed and compared observations. Document analysis began in May 2020 and continued until December 2023, and included documents from Green Platform meetings (presentations, etc.), white papers, company reports, policy documents, and research papers. The first and second authors routinely reviewed these documents separately and met to discuss findings, further refining interview questions as well as analysis of interview and meeting data.

We began with a 1st-order analysis, reviewing interview transcripts and assigning open codes to relevant passages. This resulted in a large number of coded terms, many with overlapping content. This long list was reviewed and consolidated into a more manageable number of 1st-order concepts. Next, these 1st-order concepts were reviewed in the context of secondary data, including observations from steering group meetings, project consortium meetings, physical meetings, and Responsible Innovation Lab webinars, and subsequently grouped into 2nd-order thematic codes. Considering the action research approach taken with the study, we did not attempt to "parse the interviewing and analyses," instead allowing the initial process of analysis to unfold simultaneously as we conducted interviews (Gioia et al., 2013, p. 20). This analysis was further informed by cycling between insights from participant observation of meetings and analysis of relevant documents (Gioia et al., 2013). Here, we adopted what Gioia et al. (2013) refer to as a shift from an inductive to an abductive methodology (Gioia et al., 2013; Alvesson & Kärreman, 2007), moving back and forth between our data and existing theory around SBMI, dynamic capabilities, and organizational design, attempting to derive insights from the former which could help to illuminate and develop the latter. It was at this point that we began to consider 1st-order codes and 2nd-order themes in terms of the barriers and drivers identified in Bocken and Geradts (2020). The resulting data structure is presented in Section 4, Figure 3**.**

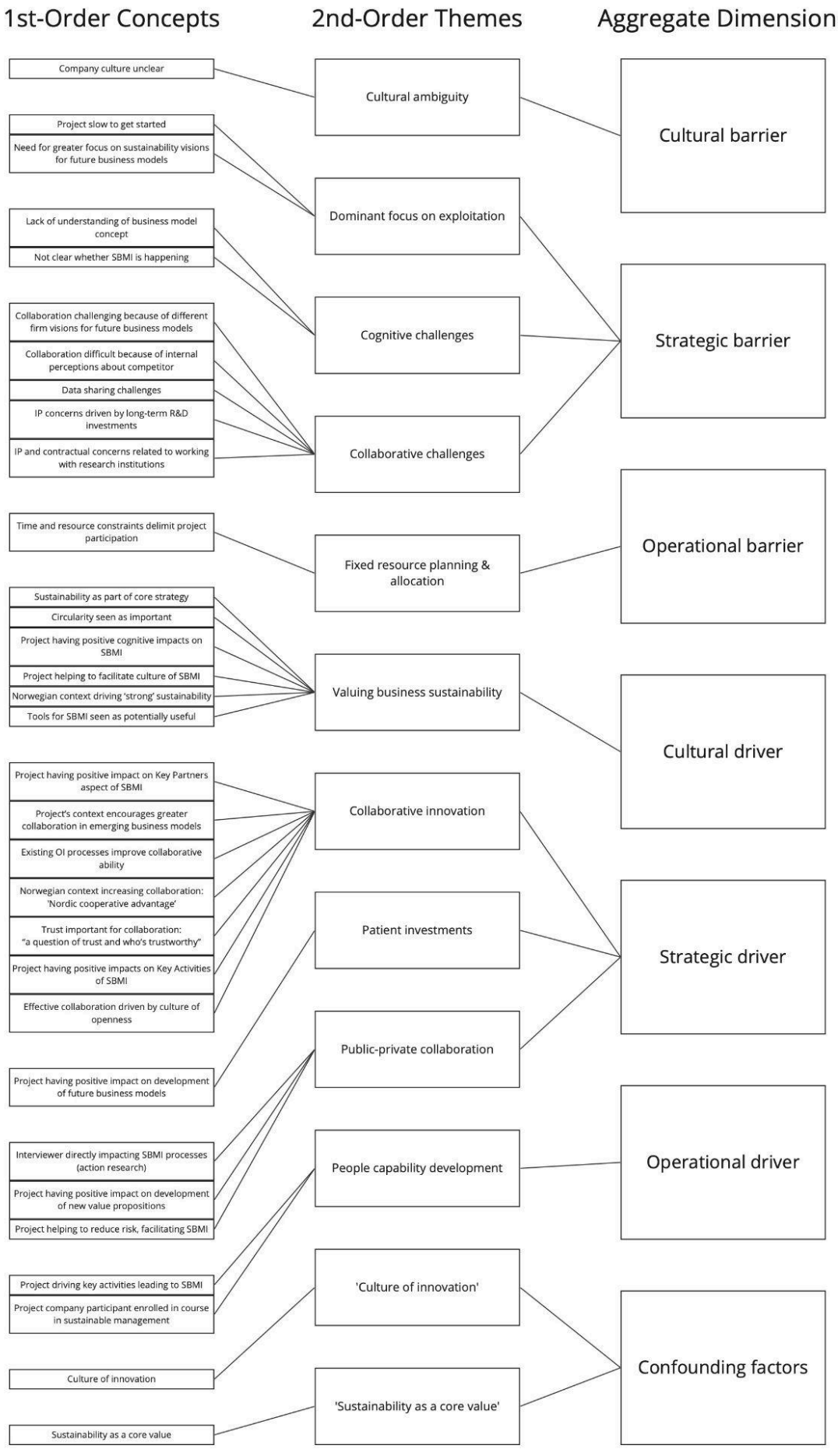

Figure 3. Data structure of this study.

4. Results

Drawing on interview data, document analysis and project meeting participation, we identified 32 unique 1st-order concepts related to SBMI in the case context (Figure 3). While the majority could be categorized into 2nd-order themes, which themselves were further grouped into aggregate dimensions (Gioia et al., 2013) as either 1) cultural, strategic, or operational barriers to SBMI, or 2) cultural, strategic, or operational drivers of SBMI, two of the 32 1st-order concepts did not fit into these dimensions and were identified as 3) confounding factors (Figure 3).

When analyzing the 1st-order concepts as organizational barriers or drivers for SBMI, three findings emerged. First, leveraging the barriers and drivers in Bocken and Geradts (2020) as a heuristic tool for analyzing our interview data and further triangulating against document analysis and notes from participant observation, we determined a number of these barriers and drivers were present in the case context. A dominant focus on exploitation (strategy) and fixed resource planning and allocation (operations) were found to be present as especially problematic barriers to developing the dynamic capabilities necessary for SBMI, while valuing business sustainability (culture), collaborative innovation and patient investments (strategy), and people capability development (operations) were present as drivers (Table 3).

Second, we noted that a number of the 1st-order concepts could not be categorized according to the barriers and drivers in Bocken and Geradts (2020), as they did not conform to these categories. At the same time, these findings seemed especially relevant in the case context and could not be ignored. This led us to consider how these concepts might be grouped into new 2nd order thematic barriers and drivers. We arrived at four new barriers and drivers, including: 1) cognitive challenges, 2) collaborative challenges, and 3) cultural ambiguity as barriers, and 4) public-private collaboration as drivers (Table 3).

Third, we identified two 1st-order concepts — ‘culture of innovation’ and ‘sustainability as a core value’ — not as drivers (despite their initial appearance as such), but rather as broader ‘confounding factors’ for developing the dynamic capabilities needed for SBMI.

4.1. Barriers

Cultural ambiguity implies a lack of clarity regarding a firm’s existing culture. Several dialogues between partners in the project (meetings, presentations) implicitly revealed that firms are in a process of cultural change, partly driven by organizational changes, and that individuals employed in the same firm may have different norms, beliefs and practices. Part of the explanation may be that firms, driven by new competency needs, have recently recruited employees with new and different educational and industrial backgrounds. As one interviewee detailed:

> “We have a culture today which is based on the founders…Next month, we are going to gather the whole company in one place, physical, and discuss about what is our culture and focus as a company, and we’ll actually discuss this company culture. So at the moment, I wouldn’t say we have a thoroughly [developed] ‘culture’ at the

> moment, because we are very fragmented [due to a recent merger]…and then we had corona, as you know, with a lot of home office, and then we have offices in…other places, so we are very fragmented."

Dominant focus on exploitation is about leveraging the existing business model and capabilities, which comes at the expense of more innovative SBMI. Meetings and other dialogues within the project revealed tendencies of a myopic focus on specific technical solutions to address sustainability challenges, and less discussion of more fundamental business model changes. Interviewees mentioned the lack of resources available to devote to sustainability-focused innovation projects such as the one examined in our case study. As lean organizations driven by long production cycles, several firms struggle to strategically prioritize business model exploration, seizing of new opportunities, and organizational transformation for sustainability, instead devoting their limited resources to exploitation of the current business model. As one interviewee commented, "time is really in short supply here."

The Green Platform project demands considerable collaboration between participating firms, and we noted that firms struggled with *collaborative challenges* at the operational and strategic level. Examples included internal perceptions about competitors with whom firms must collaborate for effective SBMI, with firms having differing visions for data sharing and the shape of future business models:

> "I foresee some challenges regarding the project, especially with [our competitor], because they have their own agenda and strategy when it comes to automatization, which is partly different from ours, because their vision is to have a fully automated facility, but our vision is not to have that - we will always have people working on our facilities…I think at least some people in our organization are a bit skeptical of that cooperation, of sharing too much information, and will not share biological production data, and [our competitor] will not show [this] to us. So, there are many constraints."

We also observed challenges around data sharing and the presence of intellectual property (IP) concerns. These were related to collaboration with research institutions, as well as IP concerns driven by long-term R&D investments (e.g., the ability of firm A to exploit some piece of IP from firm B as part of a collaborative engagement, when firm B has incurred decades of costs associated with developing and protecting this IP). One interviewee remarked that "Personally, I don't think [questions of intellectual property with our direct competitor] is a big issue. But…some people in our organization are more skeptical." Another noted that dealing with collaboration challenges, e.g., around IP, is "the most challenging part" of working on a sustainability-focused collaborative innovation project

We consider *cognitive challenges* to be a distinct strategic barrier related to conceptualization and understanding of the business model concept in general, and of sustainable business model innovation in particular. Our analysis of companies' annual reports, sustainability reports and other external communication show an evolution over time in engagement with and presentation of sustainability concerns and metrics. It is less clear from this documentation to what extent this represents an evolution in the business model, or an awareness of sustainability in terms of business models. One interviewee remarked that:

> “Very seldom [do we think about our activities in terms of a business model]…I feel it’s kind of, uh, I mean our business model is to produce a good salmon product in the ocean space. Create, deliver, and capture, I’m not sure what is kind of the difference, if you understand what I mean?”

Another noted that:

> “Maybe we could say something about that [how our business model is changing to become more sustainable] in one year or in two years, but at the moment I would not say it has changed.”

Without a clear understanding of the business model concept and conceptualization of the business in these terms, it is not obvious how firms can sense and seize SBMI opportunities.

By devoting resources primarily to exploitation of the existing business model — what we term *fixed resource planning and allocation* — firms struggle to allocate adequate time and funds to the exploration needed for SBMI. Many of the firms in our case study are extremely lean in terms of personnel and/or financial resources. Even after joining the Green Platform innovation project, which implies a certain amount of organizational buy-in for sensing, seizing and transforming for SBMI, one interviewee remarked:

> “I get the question, ‘Are we using too much time on Green Platform? Are you using too much time on Green Platform, compared to what we get out of it?’ Make sure that we always utilize that to the full, and that we are working with things in Green Platform that we in any case would have worked with. Because we don’t have time, and that’s what’s strict.”

Another noted:

> “We have never participated in such a big project. Such a multi discipline project. So that is a challenge in its own. The good thing is that people are motivated about this. But this comes on top of all the other stuff…Yeah, so it is draining resources. So that's a challenge.”

While a third commented:

> “Even though we have a big turnover, we have, we are nearly not making money and our competitors are losing money. So it is hard to get new resources.”

There have been occasions when different project partners have expressed concerns or frustration about the progress or direction of a sub-project. Our analysis of meetings and other communication between companies show that resource constraints and fragmented human resources play a role here, contributing to insufficient dialogue and collaboration on different activities.

4.2. Drivers

We observed a clear cultural driver of *valuing business sustainability.* In the Norwegian aquaculture industry, there is mounting pressure on firms to make dramatic sustainability improvements in order to obtain social license to continue operating and growing. This pressure comes both from government regulators as well as society at large, and case companies face demanding stakeholders in their global value chains. One interviewee commented that “We have a sustainability plan, and also we have operational goals…everything starts with the design space goals, and then we kind of operationalize that into our own business plan…Zero emission is of course one of the goals.”

One response to the sustainability challenges has been the Aquaculture Stewardship Council (ASC, 2023) environmental standards, with World Wildlife Fund (WWF) as sponsor. Some of our case companies have been involved in the ASC development process, and are official supporters (Nutreco Skretting) and have certified farms (Grieg Seafood and Salmar). Salmon companies have joined the global ESG risk network FAIRR (2023). According to the FAIRR index, salmon companies generally have lower ESG risk than companies producing beef, pork or poultry, including our case companies Grieg Seafood and Salmar (which were ranked 2nd and 10th among 60 protein producing companies in 2022). Grieg Seafood and Salmar have also recently issued green bonds, which requires documentation of higher environmental standards certified by a third party organization.

In the Norwegian context, high levels of trust between organizations and a ‘culture of openness’ help to fuel the strategic driver of *collaborative innovation*. From our observations of kick-off meetings and steering group meetings, we found a high degree of openness and trust between organizations being present at an early stage of the project. One interviewee remarked that “we are looking at where can we share, what can we achieve together,” while another said that “I think the whole element of trust that we have in the Norwegian society makes things so much easier.” Some firms already have open innovation processes in place strategically: “our research department…they've always been focused on working with other research institutes too.”

Patient investments implies making long-term investments which may not lead to short-term financial returns (Bocken & Geradts, 2020). While the Green Platform project is in part publicly funded, more than half of the funds come from the participating firms. Given the uncertainty regarding the pace and design of the new government regulations which need to be developed for offshore aquaculture, the long production cycle of salmon (2-3 years from egg to market), the lack of existing clarity around when and how firms will be able to begin operating offshore, and the uncertainty that exists with the development of a new value chain, the investments firms are making in offshore aquaculture are patient and long-term oriented by nature. Furthermore, after the initiation of the Green Platform initiative in 2020, we observed the entry of a company known for its long-term industrial orientation, as the industrial conglomerate Aker ASA took an ownership stake in SalmarAkerOcean, explicitly stating that this is an investment perspective towards 2030 (Aker, 2021). Referring to the future-oriented nature of current activities, one interviewee commented that “[sustainability] is kind of the basis of all we do right now…It’s like, if we don’t do this now, we’re not going to operate in the future.”

We further observed a driver of *public-private collaboration*. Firms are faced with mounting pressure from regulators to make dramatic improvements in sustainability, as evidenced in

e.g., the Paris Agreement, the EU sustainable investment taxonomy, and the Kunming-Montreal Global Biodiversity Framework (UNEP, 2022). At the same time, particularly in primary industries such as aquaculture, firms are dependent upon government license in order to operate. Governments are simultaneously motivated to drive the green transition through various policy levers, including innovation policy. Firms in primary industries must on the one hand adhere to increasingly stringent sustainability requirements, while at the same time navigating emergent regulatory frameworks.

We have observed extensive government-company interaction in the project, as the relevant government ministry and agencies have been invited to meetings where they have participated with presentations and dialogue, and contributed to development of the project's responsible innovation lab agendas. Considering that there are drawbacks to joining such projects — one interviewee noted that "it has been a challenge" working in a project with so many stakeholders — the willingness of the firms in our case study to participate in such a project is evidence that this driver is present.

People capability development for SBMI involves investing in recruitment and development programs aimed at stakeholder engagement and sustainability. Employees participating as company representatives in the Green Platform project are routinely exposed to research presentations, educational webinars, and meetings featuring status reports across project work packages. This culminates in both broad exposure to external organizations and stakeholders as well as the development of new knowledge around sustainability and innovation. One interviewee noted that "I think for me, I learned a lot about sustainability from the Green Platform project that has made me more curious about the topic," adding that they and another representative from their firm were attending a professional development course which included content on SBMI.

4.3. Confounding factors

Two of the 1st-order concepts, 'culture of innovation' and 'sustainability as a core value,' were categorized not as drivers of SBMI but rather as confounding factors. This may seem surprising, as a culture of innovation could presumably be interpreted as a cultural driver of (S)BMI, while sustainability as a core value would conceivably contribute to cultural and strategic drivers of SBMI.

While some interviewees described a 'culture of innovation' within their firms, they conflated innovation broadly with what is typical R&D. When asked about innovation, one interviewee pointed to the work of the firm's production director and technical director who are "thinking innovation day in and day out," but without any reference to business model-type innovation. Another said that "innovation is core of [sic] our business," but went on to discuss innovation primarily in terms of finding "new raw materials" for producing feed. Perhaps most telling, when asked about innovation, another interviewee even responded:

> *"R&D…it's kind of in [our] DNA."*

Second, we repeatedly heard that sustainability was 'core' to a given firm's strategy and/or cultural identity. However, we observed an incremental rather than radical interpretation of

sustainability, i.e. making incremental improvements in sustainability rather than thinking in terms of radical shifts in the business model.

5. Discussion

5.1 Contribution to theory

This study set out to investigate how organizational design, dynamic capabilities, and SBMI interact in an emergent low-carbon offshore aquaculture value chain which places new organizational and capability demands on firms. Through the case of the Green Platform project in Norway, we found that participating firms encountered various organizational barriers and drivers at the level of culture, strategy, and operations which both hindered and aided the development of the sensing, seizing, and transforming capabilities necessary to engage in SBMI (Table 3).

Recent research points out the 'black box' status of organizational design in the business model innovation context (Foss, 2023). Our aim was to build on recent work on barriers and drivers at the organizational level which help or hinder the development of dynamic capabilities for SBMI (Bocken & Geradts, 2020) — to open this black box and further clarify these relationships. Here, we discuss learnings from the case study and how they contribute to explicating these connections.

5.1.1 Organizational culture, design, dynamic capabilities, and SBMI

In line with earlier findings (Bocken & Geradts, 2020), we found that strategic barriers such as an excessive focus on exploitation and fixed resource planning hindered firms' ability to both sense and seize opportunities for SBMI, while collaborative and cognitive challenges created difficulties for seizing. Conventional inshore aquaculture relies more on incremental innovation to achieve operational efficiencies (Pandey et al., 2023), while offshore aquaculture demands more radical innovation, including business model innovation, with a longer time horizon from R&D to large-scale implementation. Companies in the aquaculture value chain are mostly lean, with employees engaged in both ongoing operations and development activities. Typically, the focus is on solutions that can have effects in the immediate or near future, which manifests as the strategic barriers we observed and create these sensing and seizing challenges.

More broadly, however, a major finding of our study was the overarching importance of organizational culture as the broader space within which organizational design, dynamic capabilities, and SBMI play out (Figure 4). While Teece (2018) presents a simplified schema for how strategy, dynamic capabilities, and business model innovation interact, this fails to adequately account for the underlying role of organizational culture, instead only considering cultural realignment as a transformation-type dynamic capability. Bocken and Geradts (2020), meanwhile, explicate organizational design in terms of the organizational

barriers and drivers which allow for the development of the dynamic capabilities needed for SBMI (Figure 1). However, their representation only addresses culture in terms of the barriers and drivers they identified.

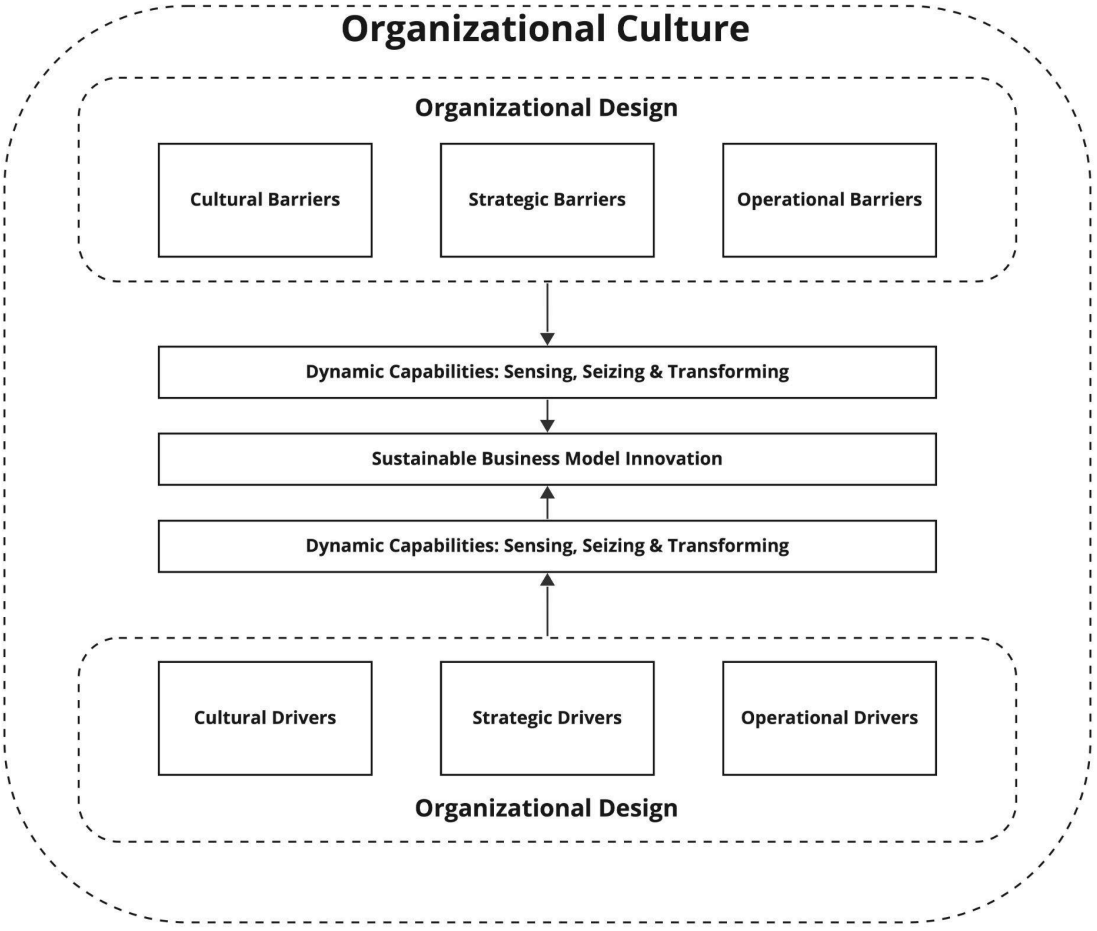

Figure 4. Framework for organizational culture, design, dynamic capabilities, and SBMI.

Drawing on the learnings from our case study and building on this previous work, we present a new framework for thinking about the relationship between organizational culture, organizational design, dynamic capabilities, and SBMI (Figure 4). In this understanding, organizational culture forms the broader space within which organizational design (and the development of dynamic capabilities, and engagement in SBMI) occurs. Culture therefore both drives and delimits an organization's strategy, which in turn manifests as an organization's day-to-day operations and operational systems (Bocken & Geradts, 2020).

Organizational culture as a kind of delimiting factor for strategic and operational activity in a firm has important implications for developing the dynamic capabilities needed for SBMI (Geradts & Bockenb, 2019). As cultural alignment around the importance, role, and meaning of 'sustainability' and 'innovation' will in turn drive both strategic and operational decision-making, the lack of clear values, norms, and routines related to sustainability and radical innovation can present a major hurdle to developing the dynamic capabilities needed for effective SBMI. Cultural ambiguity due to rapid growth (e.g. through mergers) was

particularly problematic for one firm in our case context for developing transformation-type dynamic capabilities. While we observed these cultural challenges to be somewhat mitigated by the case study organizations' valuing business sustainability, collaborative innovation, patient investments, public-private collaboration, and people capability development — all of which contributed to firms' ability to sense, seize, and transform for SBMI — without addressing fundamental cultural concerns, firms will ultimately struggle to develop the dynamic capabilities needed for effective SBMI.

Related to this, we observed two so-called 'confounding factors': the presence of what interviewees referred to as a 'culture of innovation' and 'sustainability as a core value' within the firm (see Stubbs & Cocklin, 2008). First, the 'culture of innovation' in our study was often synonymous with incremental innovation and/or innovation-as-R&D, rather than business model innovation or intrapreneurial corporate innovation (internal teams acting as miniature startups within the firm). While R&D is important, it is often insufficient for realizing SBMI in particular or business model innovation (without sustainability outcomes) in general. Osterwalder and Pigneur (2020) note a lack of correlation between what they term "traditional technology and product R&D" and innovation outcomes. Tesla, for example, spent 1/10th the amount on R&D compared to Volkswagen in 2018 ($1.5B vs. $15.3B) but had superior innovation outcomes (Osterwalder & Pigneur, 2020). This lack of correlation is analogous to startup performance, where small, innovative companies with limited resources can disrupt much larger firms. Osterwalder and Pigneur (2020) highlight the importance of what they call "business R&D" in this context, which must exist alongside traditional R&D. This involves identifying new opportunities (sensing), testing new business model ideas (seizing), and managing a portfolio of business model innovations (transforming). We maintain that the development of this kind of internal corporate innovation ecosystem requires cultural, strategic and operational alignment (Slawinski et al., 2017), with a clear understanding of the value and nature of business model innovation, including the realization that this type of innovation is distinct from traditional technology or product innovation pipelines (Chesbrough & Rosenbloom, 2002). Firms conflating R&D with SBMI therefore run the risk of getting stuck in the so-called 'design-implementation gap' (Baldassarre et al., 2020), even as they believe they have a 'culture of innovation' within the organization. Developing this kind of 'lean startup' (Ries, 2011) innovation capacity is something many large organizations struggle with, even when attempts are made to intentionally implement it (Chesbrough & Tucci, 2020). This underscores the importance of tackling barriers at the level of the underlying organizational culture to enable this kind of innovation activity in a firm.

In addition to embracing business model innovation in this way, firms aiming to succeed with SBMI should also incorporate a focus on sustainability into their core organizational values (Geradts & Bocken, 2019). While we observed many interviewees referring to 'sustainability as a core value', we found this presented as a confounding factor for succeeding with SBMI because of how sustainability was understood and operationalized within the firm. Interviewees largely viewed sustainability as incremental efficiency improvements to the existing business model, rather than radical SBMI. The former is still valuable (and may be

subsumed under what Teece (2018) terms the “second-order” microfoundations of dynamic capabilities: the adjustment, reconfiguration, and development of new ordinary capabilities), but is inadequate for delivering radical sustainability improvements through SBMI. This incremental approach to sustainability is distinct from developing the “higher order” sensing, seizing, and transforming capabilities necessary to develop “new business models to seize new or changed opportunities” (Teece, 2018, p. 40-41). In other words, firms which consider themselves to have effective sustainability strategies in place may be engaging in incremental sustainability improvements rather than radical SBMI owing to an underlying culture of incremental sustainability. It is radical SBMI however which can deliver more substantial sustainability gains as well as competitive advantage (Geissdoerfer et al., 2018; Porter & Cramer, 2011).

Developing an organizational culture which encourages business model innovation and engages more deeply with sustainability in terms of SBMI (and not purely in terms of incremental sustainability improvements) is no simple task, however. Indeed, cultural transformation is a challenging but essential ‘task’ for firms aiming to develop the dynamic capabilities needed to effectively engage in SBMI. For example, previous research has found that attempts to instill core sustainability values into an organization through a ‘trickle down effect’ from top management to day-to-day operations is often ineffective (Coffay & Bocken, 2023; Linnenluecke & Griffiths, 2010; Harris and Crane, 2002). Indeed, culture-shifting intervention can be one of the most challenging tasks a firm can engage in. Teece (2018) considers this ‘realigning of culture’ — an important activity in tackling organizational design — as actually *constitutive* of transformation-type dynamic capabilities (p. 44). Culture needs to be nurtured and supported by organizational dimensions such as clear direction, room for collaboration, and goals and measures (Geradts & Bocken, 2019). We concur with the central role that cultural transformation plays in meeting sustainability goals, but would expand on its significance for (S)BMI, as Teece’s characterization creates a potential chicken-and-egg problem in the context of organizational design and dynamic capabilities. If on the one hand organizational design (e.g. goals, team structure) delimits and determines a firm’s ability to develop the dynamic capabilities necessary for (S)BMI, but at the same time realigning an organization’s culture (e.g., for sustainability) is itself a transformation-type dynamic capability, then organizations become stuck. They need to reinvent themselves on a cultural level to pave the way for improved dynamic capabilities and SBMI — but doing so is itself a dynamic capability which the organization may not at present possess. This tension is reflected in Figure 4, where organizational culture forms the backdrop on which dynamic capabilities are developed.

As confirmed in our case study, developing dynamic capabilities is therefore not as simple as instituting a particular strategic or operational change, as such changes must be reinforced and undergirded by a culture of sustainable innovation which is embedded in a broader management philosophy. As Teece (2023) argues, dynamic capabilities must be built because they cannot be bought. This is partly because they involve managerial cognition and learning(Teece, 2023; Adner & Helfat, 2003). Indeed, managers need to become entrepreneurial to develop and maintain strong dynamic capabilities (Teece, 2023), and this entrepreneurial spirit must become embedded in organizational culture broadly, but in particular the organizational norms which guide managerial behavior. At the same time, since the ability to implement cultural shifts is itself a transformative dynamic capability, organizations may need to do a considerable amount of heavy lifting up front to initiate

transformative organizational design processes. Conceptual tools are essential for providing guidance and structure in these instances, where an inability to leverage effective tools for SBMI has been identified as a key factor in the SBMI design-implementation gap (Coffay & Bocken, 2023; Geissdoerfer et al., 2018). Furthermore, awareness of the building blocks that support and nurture a sustainable innovation culture (e.g. room for collaboration, resources and budget, and a clear direction and goal) are needed to transform the organization.

5.1.2. Public-private and cross-firm collaboration

Our case was situated within a collaborative public-private innovation project context, where a number of firms and research institutions are working together to develop innovations for a sustainable low carbon offshore aquaculture value chain. We observed that collaboration played a central role in the case, with both successful collaboration and collaborative challenges presenting simultaneously. Recent work by George et al. (2023) underscores the relevance of organizational design considerations for public-private collaborations aimed at addressing grand challenges, while Bogers et al. (2019) have specifically highlighted the relevance of the dynamic capabilities perspective on open innovation. As such, our study reveals some of the ways in which public-private partnerships enable sensing, seizing and transformation across organizational boundaries in the face of a grand challenge, as well as how collaborative challenges (e.g., around IP, data sharing, and conflicting visions) can present in these contexts.

In our study, we observed a particularly strong effect of the ‘collaborative innovation’ and ‘public-private collaboration’ drivers. While this is embedded in the strong need for upstream and downstream collaboration to create an entirely new value chain for offshore aquaculture, it also begs the question whether particular barriers and drivers may be more salient in specific industries (Bocken & Geradts, 2020). In a primary industry like aquaculture — where license to operate is dependent upon social license and complex regulations — collaboration, openness, and a willingness to engage with and accommodate the concerns of a wide range of stakeholders is essential to developing the dynamic capabilities needed for SBMI. In particular, we find that collaborative capacity, important for developing new sustainable business models (Brown et al., 2018; Velter et al., 2022), is particularly essential for both sensing- and seizing-type capabilities. Through effective collaboration within a new value chain, firms can both sense new opportunities for SBMI and work together to seize them, while de-risking their activity from a regulatory perspective. Collaborative capacity is also necessary for transformation in this primary industry context, where new sustainable business models are dependent upon building relationships with external stakeholders throughout the value chain, including both other firms and policymakers, as the industry is heavily regulated (Pandey et al., 2023). Involving existing stakeholders can also help them identify and co-create their potentially new roles in the sustainable business model early on (Brown et al., 2020; Velter et al., 2022). Only through this kind of multi-stakeholder collaboration will firms be able to achieve scale while transforming the business to optimize for sustainability considerations (see also Geissdoerfer et al., 2018; Velter et al., 2022).

Despite the presence of collaborative drivers, we simultaneously identified a ‘collaborative challenges’ (Strategic) barrier. Internal perceptions regarding the long-term compatibility of multiple firms’ business models, as well as concerns regarding intellectual property (IP) and the need to both share data while protecting IP can hamper collaboration for SBMI (Bogers,

2011). This lack of collaboration can lead to inadequate sensing and seizing capabilities, making it difficult for firms to either identify or act upon SBMI opportunities. To some extent, the success or failure of firms with SBMI in complex industry contexts like the one observed in our case may hinge upon their ability to collaborate for sensing and seizing of new opportunities (Bogers et al., 2019). A joint goal, vision or purpose focused on sustainability may counteract this barrier by uniting stakeholders towards the development of a sustainable business model (Bocken & Geradts, 2020; Brown et al., 2021). Such a process may be initiated by a focal firm (e.g. incumbent aquaculture firm) inviting its key stakeholders to the SBMI process to get their buy-in early on (Brown et al., 2021; Velter et al., 2022).

5.2. Implications for practice

The food system is characterized by unsustainable business models, and SBMI holds the potential to unlock substantial sustainability improvements which technological innovation alone cannot achieve (Bocken & Short, 2021). Our case study revealed the value of SBMI thinking for aquaculture specifically and primary industries in general, as well as the organizational barriers and drivers which must be addressed for firms in the Norwegian aquaculture industry to develop the sensing, seizing, and transforming capabilities needed for SBMI.

Mitigation of environmental and biological externalities in salmon aquaculture requires coordinated public-private action leveraging e.g., legal, organizational, and technological tools (Afewerki et al., 2022). For salmon companies this involves SBMI, particularly around key partners, key activities, key resources, and the value proposition. Conventional thinking about business model innovation largely ignores the role of social license, focusing instead on key partnerships with private suppliers (Osterwalder & Pigneur, 2010). Particularly in primary industries, however, a successful business model must recognize public license as a key resource, related stakeholders (e.g., local communities, researcher institutions, NGOs, and government) as key partners, and maintenance and development of relationships with these partners as key activities (Misund et al., 2023). This involves developing a value proposition which satisfies customer segments and stakeholder expectations.

Salmon companies have struggled in recent decades to innovate their business models when faced with sustainability challenges. Moving to an offshore value chain presents firms with the most substantial challenge to their existing business models to date, with new biological and environmental risks, value chain configurations, technologies, and public regulatory frameworks. Success depends on developing and mobilizing a diverse set of human and organizational resources external to salmon companies. Such resources reside in research organizations, government agencies, and supplier companies. They are needed for new knowledge production and innovation in a range of areas, including marine biology, offshore installations, electrification, digitalization, automation, health and safety legislation and standards, and licensing. Some competencies can in principle be insourced, but many are impractical or even precluded as they are in the domain of government institutions. Teece (2023) notes the importance of transformational dynamic capabilities for succeeding with the implementation of new business models, arguing gaps in these capabilities must be addressed with “internal development, acquisition, or alliance” (p. 121). Salmon companies’ ability to nudge external organizations and leverage their resources depend critically on changes in the companies’ organizational design and business models. Current designs do

not appear sufficient to meet the new challenges of offshore production. The same may hold true for other primary industries, where companies operating with conventional business models and organizational designs are faced with mounting environmental externalities and new regulatory pressures.

While interviews revealed that managerial respondents do not always think in terms of 'business models', they did use mental models for conceiving of strategic and operational excellence. Martins et al. (2015) conceive business models as mental models and argue for the ability to engage in business model innovation through proactive managerial cognition. However, as Massa et al. (2017) note, this approach to conceptualizing business models as a pure cognitive schema is just one way in which researchers have envisioned the business model concept, with others considering business models as actual attributes of firms or scaled-down formal representations of firm activity. We suggest that greater cognitive engagement on the part of managers with the business model concept and organizational design will allow aquaculture firms to prioritize the development of dynamic capabilities for sensing new opportunities, seizing them, and transforming the existing culture and business model. Doing so, however, will first require that firms recognize and act to mitigate the barriers of cultural ambiguity, a dominant focus on exploitation, collaborative challenges, cognitive challenges, and fixed resource planning and allocation. At the same time, while we identified several organizational drivers present in the firms we analyzed, a number of drivers were distinctively *not present*. Introducing and then boosting these organizational drivers will be critical for developing the sensing, seizing, and transforming capabilities needed for SBMI. For example, organizational dimensions such as a clear direction and goals for employees, room to innovate as well as budgets and resources are essential to build a culture for innovation and stimulate sensing, seizing and transforming capabilities needed for SBMI (Geradts & Bocken, 2019).

Firms should focus on balancing shareholder and stakeholder value and prioritize a strategic focus on SBMI. Inshore aquaculture has created a lot of local 'winner' communities with farms and processing facilities. With offshore aquaculture, a small number of 'winner' communities will emerge where industry anchors as production moves offshore. Reduced inshore environmental impacts may be accompanied by reduced coastal job creation. Firms aiming to balance economic, environmental, and social value through SBMI should therefore carefully consider how they approach shareholder-stakeholder value in their organizational culture. This is equally important for firms in other primary industries, where the greening of business models could have unintended rebound effects related to social impacts.

While many firms would claim that sustainability is a part of their strategy, this strategic focus is sometimes embodied in incremental improvements in technology, buyer-supplier relationships, efficiencies, etc. By contrast, a strategic focus on SBMI will need to consider how the various components of a sustainable business model fit together, including which key partners (stakeholders) to engage, which key activities to pursue, and which external resources to leverage — all with the aim of developing a value proposition which not only satisfies customer segments, but also allows firms to obtain social license to operate. Such a need is further reflected in the emergent European Corporate Sustainability Reporting Directive, which specifically mandates that firms report on how their business model and strategy account for stakeholder interests, sustainability risks, sustainability impacts, and the broader transition to a sustainable economy (EU, 2022).

5.3. Limitations

While the research conducted here provides valuable insights for practitioners and advances the emergent body of theory around organizational design, dynamic capabilities, and SBMI, the research also had several limitations.

First, the methodological approach which we chose — a case study with elements of action research — presents unique challenges related to maintaining adequate distance from the data, particularly when it comes to analysis and presentation of findings. We addressed this challenge by having one author maintain distance from the data while another worked more closely with it. However, it is impossible to entirely avoid the potential of role conflicts, and it is important to acknowledge how our participation in the innovation project may have colored our analysis (Wittmayer & Schäpke, 2014). Still, we argue that the need for rapid decarbonization and the transition to sustainable forms of production and consumption necessitate new and more engaged roles for researchers in the management literature (Coffay & Tveterås, 2023).

Second, the case examined here deals with an innovation project still underway at the time of writing. We therefore are only able to offer analysis and reflections of an ongoing process, rather than drawing conclusions based on a process which has been completed. Waiting until the project was completed would undoubtedly have resulted in further insights which could have been included here.

6. Conclusion

Firms increasingly must grapple with sustainability challenges. Innovation at the business model level can help achieve radical sustainability improvements. Taking our starting point in recent research on the interrelatedness of (sustainable) business model innovation, dynamic capabilities, and organizational design, we conducted a case study of an emergent low-carbon offshore aquaculture value chain in Norway. Leveraging this unique case context within the food sector — where unsustainable business models are rampant and SBMI is very much needed — the paper made three contributions to the literature. First, we identified those organizational barriers and drivers present in a particular industry context (Norwegian salmon aquaculture). Second, we added to the body of theory around the relationship between organizational culture, organizational design, dynamic capabilities, and SBMI. We identified new barriers and drivers present in our case context which could also be particularly relevant in other primary industry contexts. We noted the challenges for developing sensing, seizing, and transforming capabilities created by various organizational barriers and drivers, highlighting the importance of collaboration for SBMI as well as the role of culture in driving strategic and operational alignment for SBMI. Third, we connected these insights with managerial implications for the aquaculture industry in particular, and for firms in primary industries more broadly.

Cultural transformation is a particular challenge for companies engaging in SBMI. While cultural transformation is essential for creating an organization that supports the development of dynamic capabilities for sustainable innovation, the ability to successfully undertake this kind of transformation can itself be understood as a higher-order dynamic

capability. This implies that firms struggling with SBMI will have to prioritize cultural transformation in order to effectively drive strategic and operational shifts and develop the necessary capabilities. Future research could investigate this kind of transformative activity through longitudinal case studies, action research, and the application of research-based tools for organizational design.

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Table 1. Data collection table: interviews.

#	Company	Position	Experience
1	BluePlanet / Stiim Aqua Cluster	Senior Manager	Food industry marketing manager, aquaculture industry entrepreneurship and innovation processes
2	SalmarAkerOcean	Business Analyst	Finance manager manufac turing company, project leader sustainability and business support in SAO
3	Skretting	Sustainability & Public Affairs	Marketing and branding innovation and management, project management in several companies
4	Grieg Seafood	R&D Manager	Fish health research, R&D management in aquaculture R&D institution and companies
5	FishGlobe	General Manager	Engineer and management experience in aerospace/defense, oil and gas companies
6	Skretting	Marketing & Sustainability	Product manager, marketing and sustainability director
7	Moreld Aqua	Digitalization	Project manager and sales manager in several companies, primarily oil and gas supply chain

Table 2. Data collection table: meetings.

#	Type	Details
1	Two funding application preparation meetings between consortium companies	All companies and leading research organizations discussing objectives, tasks, deliverables, division of labor, organization of project, management, funding, steering group.
2	Presentation of Green project to Ministry of Industry, Trade and Fisheries by all consortium partners	All companies and research organizations presenting objectives, tasks, deliverables to the Ministry (represented by state secretary and bureaucrats).
3	Green Platform consortium	Feedback and questions on project application

	interviewed by government funding agencies	from four reviewers to representatives of all project consortium members.
4	Project preparation meeting between all consortium partners	Contractual issues and practical organization of sub-project activities etc.
5	Eight steering group meetings	All companies and leading research organizations discussing specification of contracts, IP issues discussed, further development of activities and organization.
6	Digital kickoff meeting, all consortium partners	Presentation of sub-projects and work packages to a large group of consortium company employees and researchers from all R&D institutions
7	Four steering group meetings	All companies and leading research organizations discussing contractual issues and practical organization of sub-project activities etc.
8	Physical kickoff meeting all consortium partners and external stakeholders	Mutual learning about sub-projects and work packages, coordination of activities
9	Twelve steering group meetings	All companies and leading research organizations discussing contractual issues, follow-up on activities and deliverables
10	Webinar, Responsible Innovation Lab	Presentation by researchers of Responsible Innovation Lab and its activities within project to all project participants
11	Webinar, Responsible Innovation Lab	Presentation by researchers of environmental indicators to all project participants, followed by a discussion
12	Webinar, Responsible Innovation Lab	Presentation by researchers of issues related to secure and resilient offshore aquaculture to all project participants, followed by discussion
13	Physical meeting all consortium partners and external stakeholders	Mutual learning about activities and results of sub-projects and work packages involving over 50 project participants through presentations and group work
14	Four steering group meetings	All companies and leading research organizations discussing activities and deliverables, and actions needed
15	Approximately 50 meetings with one or more partners on different issues	Project management discussing various issues with one or more consortium partners, including contract specifications, objectives, milestones, activities, deliverables, collaboration problems, resource use and availability.

Table 3. Barriers and drivers to SBMI identified in case study. Note. An asterisk denotes where the factor differs from the Bocken and Geradts (2020) study.

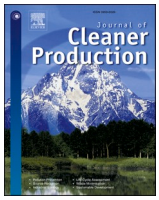
Type	Barriers	Drivers
Cultural	Cultural ambiguity*	Valuing business sustainability
Strategic	Dominant focus on exploitation	Collaborative innovation
	Collaborative challenges*	Patient investments
	Cognitive challenges*	Public-private collaboration*
Operational	Fixed resource planning and allocation	People capability development

Journal of Cleaner Production 427 (2023) 139294

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Sustainable by design: An organizational design tool for sustainable business model innovation

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ARTICLE INFO

Handling Editor: Lei Shi

Keywords:
Sustainable business model
Dynamic capabilities
Organization design
Sustainability tool
Design thinking
Business model innovation

ABSTRACT

When firms want to meet ambitious sustainability targets, they often fail to deliver on more radical innovation at the level of the business model. They often struggle to design and successfully implement new, sustainable business models in practice. While sustainability tools might help bridge the design-implementation gap in business, they often lack a grounding in both theory and practice. In this study, we build on empirical research that recognises the importance of dynamic capabilities to develop sustainable business models, and the barriers and drivers that might exist at the organizational level. We investigate the following research question: How can firms address organizational design issues in order to develop the dynamic capabilities necessary for sustainable business model innovation? The research method consists of four stages derived from the iterative, user-involved method of design science research: 1) identifying the problem and defining objectives for a solution; 2) design and development; 3) demonstration; and 4) evaluation. The work results in the "Sustainable By Design" tool which was used in a workshop setting with two large multinational companies seen as sustainability leaders in their sectors: DSM and IKEA Retail (Ingka Group). The work makes two contributions. First, we contribute the Sustainable By Design tool which practitioners can use to evaluate their current organizational design, identify barriers and drivers for sustainable business model innovation, and develop strategic interventions to engage in organizational transformation. Second, we elucidate the theoretical connections between organizational design, dynamic capabilities, and sustainable business model innovation, and suggest directions for future research.

1. Introduction

While firms increasingly recognize the need to implement sustainability improvements, they often struggle to meet sustainability targets (Geissdoerfer et al., 2018). Radical innovation at the level of the business model — how a firm creates, captures, and delivers value — is often needed to achieve sustainability goals (Rashid et al., 2013). Traditional business model innovation — the act of devising new, innovative business models by altering existing models and/or designing and implementing new ones — can yield higher returns than product or process innovation alone (Chesbrough, 2007). Meanwhile, sustainable business model innovation (SBMI) — the act of designing and implementing new, sustainable business models (SBMs), i.e. those which "create significant positive [impact] and/or significantly reduced negative impacts for the environment and society, through changes in the way the organization and its value-network create, deliver value and capture value … or change their value propositions" (Bocken et al., 2014, p. 44) — offers firms a number of tangible firm- and sustainability-focused benefits (Geissdoerfer et al., 2018; Bocken and Geradts, 2020). It can mitigate long-term risk (Choi and Wang, 2009), improve resilience (Buliga et al., 2016), reveal new diversification and value creation opportunities (Nidumolu et al., 2009; Tukker and Tischner, 2006), provide competitive advantage (Porter and Kramer, 2011), reduce costs (Bocken et al., 2014), anticipate future legislation and stakeholder expectations (Schaltegger et al., 2012), boost reputation (Homburg et al., 2013) and attractiveness for top talent (Greening and Turban, 2000), and address long-term sustainability challenges (Bocken and Geradts, 2020; Foss and Saebi, 2017; Laasch, 2019).

However, despite the purported benefits of SBMI and its importance for meeting sustainability targets, there remains a design-implementation gap: companies struggle to successfully design and implement new SBMs (Baldassarre et al., 2020). The process of business model innovation is less clear-cut than product innovation (Chesbrough, 2010) and sustainability adds another layer of complexity by the need to

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https://doi.org/10.1016/j.jclepro.2023.139294
Received 19 January 2023; Received in revised form 27 September 2023; Accepted 13 October 2023
Available online 14 October 2023

satisfy multiple stakeholder demands and create a triple-, rather than a single bottom line impact (Stubbs and Cocklin, 2008). Moreover, there is a lack of tried and tested processes and tools to support the SBMI process (Geissdoerfer et al., 2018; Bocken et al., 2019). While established tools exist for traditional business model innovation (e.g. the Business Model Canvas (Osterwalder and Pigneur, 2010)), tools for SBMI are manifold (Pieroni et al., 2019) but often suffer from design issues, have not been adequately tested and evaluated in practitioner contexts, and/or were designed for specific contexts, thus lacking broader applicability (Bocken et al., 2019).

Recently, it has also been determined that firms often lack the dynamic capabilities to engage in SBMI (Bocken and Geradts, 2020). Dynamic capabilities refer to an organization's ability to "integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al., 1997), often understood as the ability to sense and seize new opportunities and transform the organization. Whereas companies already have difficulty innovating their business models in general (Chesbrough, 2010; Teece, 2018), SBMI is even more challenging given the extra demands to fulfill societal and environmental needs on top of a superior customer offering (Bocken and Geradts, 2020; Boons and Lüdeke-Freund, 2013; Stubbs and Cocklin, 2008). Further, recent research has highlighted the importance of organizational design for developing dynamic capabilities in general (Teece, 2018) and for SBMI in particular (Bocken and Geradts, 2020). A tool which can help firms build dynamic capabilities for SBMI by addressing fundamental organizational design considerations could therefore prove useful for organizations attempting to design and implement new SBMs. Such a tool could give firms a concrete process to follow to succeed with SBMI, beginning with tackling organizational design.

This paper therefore investigates the following research question: *How can firms address organizational design issues in order to develop the dynamic capabilities necessary for sustainable business model innovation?*

Here, we address this research question by developing a tool for organizational design to bridge the gap between SBMI theory and practice (Baldassarre et al., 2020). We do so by following a design science research methodology and drawing on recent developments in theory, along with empirical interview data. Section 2 further discusses the relevant concepts operationalized in the development of the tool, including sustainable business model innovation, dynamic capabilities, and organizational design, while also describing the research focus and gap in more detail. Section 3 provides a detailed account of our methodological approach. Section 4 presents the results of the research in the form of the Sustainable By Design tool which emerged from the design science process. Section 5 discusses these results, the tool's relevance for organizational design and sustainable business model innovation, and contributions to theory derived from the tool development process. It also presents the limitations of the study and avenues for further research. Section 6 provides a conclusion.

2. Background

2.1. Sustainable business model innovation

Conceptually, the idea of 'sustainable business model innovation' (SBMI) is comprised of several component concepts: business model; sustainable business model; and business model innovation.

A business model is a representation of the way a firm creates, captures, and delivers value (Osterwalder and Pigneur, 2010). Thinking in terms of business models has become increasingly important for firms and practitioners over the past decade, with differentiation at the business model level emerging as a clear source of competitive advantage for firms as opposed to e.g. a pure focus on technology (Chesbrough, 2007).

Sustainable business models are distinct from 'conventional' business models insofar as they "incorporate pro-active multi-stakeholder management, the creation of monetary and non-monetary value for a broad range of stakeholders, and hold a long-term perspective" (Geissdoerfer et al., 2018, p. 403–404). As environmental risk grows and places increasing amounts of pressure on companies worldwide — regardless of size or sector — sustainable business models can be a source of competitive advantage (Porter and Kramer, 2011). Geissdoerfer et al. (2018) suggest that continuing environmental trends could lead to the concept of sustainable competitive advantage eventually replacing conventional conceptions of competitive advantage (Grant, 2010).

Business model innovation can be understood in a number of ways, depending on how the notion of a business model is conceptualized ontologically, e.g. whether a business model is primarily seen as a collection of components (Osterwalder and Pigneur, 2010), the "activity system" of the firm (Zott and Amit, 2010), a cognitive representation which allows for the classification of different businesses (Baden-Fuller and Morgan, 2010), or as a "conceptual representation of how a business functions" (Snihur and Bocken, 2022, p. 2; Massa et al., 2017). Given that this research aims to develop research output in the form of a tool which can be utilized by practitioners, and in light of the popularity and practical importance of the component-type definition found in Osterwalder and Pigneur (2010), creators of the business model canvas, we adopt this approach to conceptualizing business models in this paper. With this in mind, business model innovation can then be understood in general as innovation activity aimed at the development and launch of new business models into a market space (Snihur and Zott, 2020) or as the introduction of incremental changes to existing business models (Geissdoerfer et al., 2018), but more specifically as engaging in a process of design. By "specifying a set of business model elements and building blocks, as well as their relationships to one another," one can become a "business model designer" who "can experiment with these blocks and create completely new business models, limited only by imagination and the pieces supplied" (Osterwalder and Pigneur, 2005, p. 24; quoted in Geissdoerfer et al., 2018).

Sustainable business model innovation (SBMI), then, can be understood as business model innovation which aims to "create significant positive and/or significantly reduced negative impacts for the environment and/or society, through changes in the way the organization and its value-network create, deliver value and capture value (i.e. create economic value) or change their value propositions" (Bocken et al., 2014, p. 44). For incumbent businesses aiming to grow new revenue streams while also achieving their sustainability goals and reducing environmental risk, SBMI is becoming increasingly important (Schaltegger et al., 2012). This is true for large incumbents, SMEs, startups, and scaleups alike (Bocken et al., 2014; Henry et al., 2020; Bashir et al., 2022). Particularly for large incumbent organizations, however, thinking in terms of SBMI can provide grounding for innovation processes. It can help them to systematically develop disruptive innovation capable of generating exponential gains in revenue by crossing boundaries into entirely new industries. At the same time, it can help place sustainability concerns front and center by incorporating them into the fundamental components of a new business model.

2.2. Organization design and dynamic capabilities

Organizational design is closely linked to how successfully a firm can transform its business models. Organizational design can include the "values, beliefs, and assumptions that guide [management's] leadership and decision-making approaches," as well as an organization's "strategy, people, structure, and management processes" (Bocken and Geradts, 2020, p.3; Burton et al., 2006; Galbraith, 1974; Meyer et al., 1993; Miles and Snow, 1978; Miles and Creed, 1995). Tushman et al. (2010) for instance consider four ideal organizational design types — functional, cross-functional, spinout, and ambidextrous — and assess their impact on innovation outcomes. Their findings indicate that ambidextrous organizations, or those with "intra-organizational design

heterogeneity that is consistent with the contrasting strategic requirements of exploration and exploitation," where "exploitative subunits are organized to be efficient, while exploratory subunits are organized to experiment and improvise" (p. 1336) are more effective in "executing innovation streams" (p. 1331).

Theory on dynamic capabilities has been linked to organization design (Fjeldstad and Snow, 2018; Teece, 2018) as it is also seen as an important theory explaining a firm's long-term competitiveness. To illustrate, emerging research underscores the connections between organizational design, dynamic capabilities, and SBMI. Teece (2018) considers the impact of organizational design on developing the dynamic capabilities for conventional business model innovation, arguing that dynamic capabilities are underpinned by organizational routines and managerial skills. Fjeldstad and Snow (2018) discuss how new collaborative organizational forms enable open and agile business models. Leih et al. (2015) note that "an organization's structure, incentives, and culture" may be "more or less well suited to the recognition of new opportunities" (p. 1). Bocken and Geradts (2020) explore how organizational design impacts development of dynamic capabilities for sustainable business model innovation specifically.

Indeed, the concept of dynamic capabilities was first presented in Teece et al. (1997) as an alternative theory of firm competitive advantage. Unlike the resource-based view of the firm (Penrose, 1959), wherein firms are thought to derive competitive advantage from a unique set of internal resources, the notion of dynamic capabilities suggests that it is firms' ability to "coordinate and redeploy internal and external competencies" — while also being innovative, responsive, and flexible — which affords competitive advantage (Teece et al., 1997, p. 515). The dynamic capabilities concept has become more prominent in a VUCA (volatile, uncertain, complex, and ambiguous) world, (Bocken and Konietzko, 2022; Schoemaker et al., 2018), where companies need to change their business models more rapidly based on faster-paced and unexpected threats and opportunities.

Following Teece (2018), firms have both ordinary and dynamic capabilities. The former are composed of "routine activities" involved in the operationalization of the firm's existing business model (Teece, 2018, p. 40). Dynamic capabilities, on the other hand, are understood in terms of 'sensing', 'seizing', and 'transforming', namely: "the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets" (Teece, 2007, p. 1319). Teece (2018) elaborates on this definition by noting that the process of "[devising] new business models to seize new or changed opportunities" is an important component of dynamic capabilities (p. 40–41).

Organization design aspects have been investigated for SBMI (Bocken and Geradts, 2020). Bocken and Geradts (2020) consider the importance of dynamic capabilities for SBMI, suggesting that it is through developing the appropriate dynamic capabilities that firms are able to successfully engage in the activities necessary for SBMI (see also Inigo et al., 2017; Sommer, 2012). Firms must first be able to *sense* both potential threats (e.g. environmental externalities) as well as opportunities (e.g. the ability to capitalize on sustainability-related business opportunities through connecting with customer sentiment) in order to act on SBMI (Bocken and Geradts, 2020; McWilliams and Siegel, 2011; Hart and Dowell, 2011). Once opportunities and risks have been sensed, firms must then have the capabilities needed to *seize* these opportunities, "mobilizing resources to address emerging (sustainability) opportunities and capture value from doing so" (Bocken and Geradts, 2020, p. 3; Teece, 2018). Importantly, firms must finally have the ability to engage in *transformation* via the "deliberate continued renewal of the organization's capabilities (Teece, 2018) towards becoming a sustainable business" (Bocken and Geradts, 2020, p. 3). The ability to engage in this kind of ongoing organizational renewal is especially important in a sustainability context, as the journey towards sustainability is ongoing. Given the shifting nature of sustainability targets, the wicked nature of sustainability challenges, and the uncertainty surrounding innovation processes, sustainability is not an end goal but rather an ongoing pursuit, one requiring transformation-type capabilities (Coffay et al., 2022). Teece (2018) sees a firm's cultural realignment as an important component of transformation-type dynamic capabilities, which we argue underscores the importance of company culture for determining a firm's ability to succeed with both conventional as well as sustainable business model innovation.

Although much of the literature on organizational design is somewhat opaque, Bocken and Geradts (2020) clarify the concept by considering it in terms of three levels of analysis: institutional, strategic, and operational, echoing earlier work on organizational levels of inaction towards sustainability by Slawinski et al. (2017) (Fig. 1). At the organizational design level, an organization's institutional factors drive the development of strategy, which is then deployed at the operational level. This institutional-strategic-operational relationship is undergirded by various organizational barriers and drivers, which can either contribute to or hinder the development of the dynamic capabilities needed for SBMI as also depicted in Fig. 1.

2.3. Research focus

Despite the potential for SBMI to contribute to significant positive outcomes for firms, there is a substantial 'design-implementation gap': firms struggle with designing and successfully implementing new, sustainable business models in practice (Geissdoerfer et al., 2018; Baldassarre et al., 2020). Geissdoerfer et al. (2018) identify several reasons for the existence of this gap, including a lack of good tools for SBMI. Based on other research we also see the lack of a unified process for business model innovation more generally (Chesbrough, 2010) or SBMI in particular (Bocken et al., 2019; Pieroni et al., 2019). More tools have emerged in recent years (Pieroni et al., 2019), but many of them suffer from design flaws, have not been adequately tested in practitioner contexts, and/or have not been built from theory and practice (Bocken et al., 2019). This confirms earlier research by Baumann et al. (2002) which identified a number of sustainability tools, but each with certain design flaws that inhibit the use of such tools in practice – in particular the lack of testing in practice. The growing number of tools also shows the lack of a unified approach to SBMI and that this research field is still emergent.

Given the theory and literature context outlined above, the research focus of this paper is twofold. First, we aim to better elucidate the theoretical connections between organizational design, dynamic capabilities, and sustainable business model innovation, building on work by researchers such as Inigo et al. (2017), Teece (2018), and Bocken and Geradts (2020). In particular, we develop a clearer understanding of the organizational barriers and drivers which can impact the development of the sensing, seizing, and transforming capabilities needed for SBMI. Second, we approach this task by developing a tool which practitioners can use to evaluate their current organizational design, identify barriers and drivers for SBMI, and subsequently develop strategic interventions to engage in organizational transformation. We suggest that such a tool could help firms approach SBMI with a more structured process, beginning first of all with addressing organizational design through the identification of cultural, strategic, and operational barriers and drivers to SBMI.

In the Method section, we will explain how we develop this tool by leveraging empirical data on organizational barriers and drivers to SBMI as described in Bocken and Geradts (2020). Drawing on previous work in organizational design and dynamic capabilities (Teece, 2018; Fjeldstad and Snow, 2018; Leih et al., 2015), Bocken and Geradts (2020) conducted 56 interviews with top, senior, and mid-level management from 7 multinational corporations engaged in SBMI, including Philips, Unilever, AkzoNobel, Johnson & Johnson, and Pearson. Interviewees were asked to identify organizational factors that supported or inhibited SBMI processes. Analysis of responses revealed common themes across

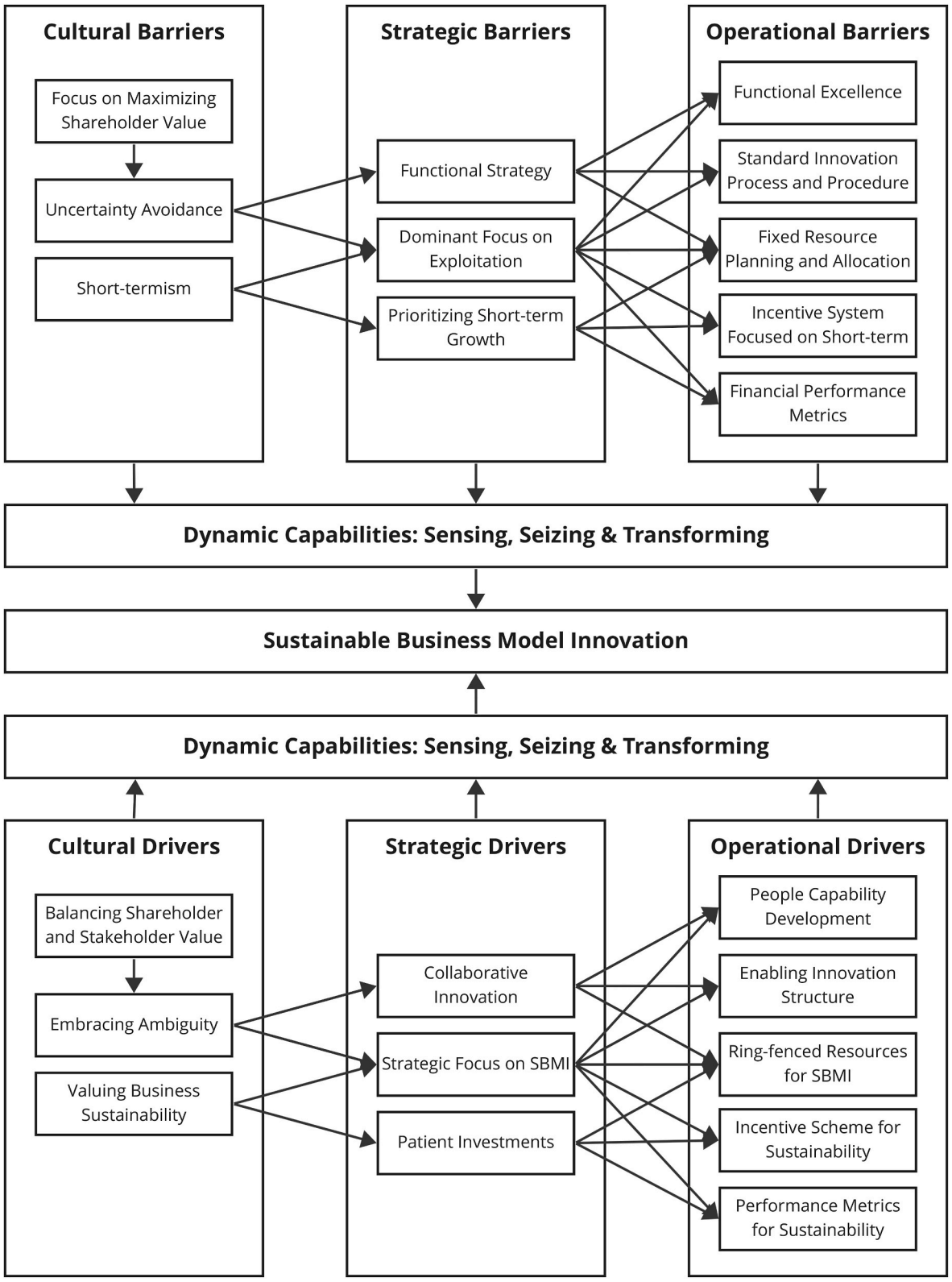

Fig. 1. Identifying barriers and drivers at the organizational level for SBMI. Adapted from Bocken and Geradts (2020).

very different industries and innovation projects, as depicted in Fig. 1.

By developing and testing a tool grounded in this empirical data, the present paper aims to build on this earlier work to further illuminate the significance of specific organizational barriers and drivers for dynamic capabilities and SBMI, while also bridging the theory-practice gap by providing practitioners with an actionable tool that can help them identify organizational barriers and drivers to SBMI present in their organization.

3. Method

This research investigates how firms can address organizational

design issues to develop the dynamic capabilities necessary for sustainable business model innovation. Design science research (Peffers et al., 2007) was found to be useful to approach this question because of the involvement of the target group in the development of the tool to demonstrate its usage. The iterative, user-involved method of design science research has been applied to develop sustainable business tools before (see e.g. Baldassarre et al., 2020).

The method consisted of four stages building on Peffers et al. (2007): 1) identifying the problem and defining objectives for a solution; 2) design and development; 3) demonstration; and 4) evaluation. While Peffers et al. (2007) also add 'communication' as a separate step, we consider communication as manifest in the ongoing interactions we have had with the companies involved regarding deployment and results of the tool, as well as in the publication and dissemination of this article. These steps of the design science process are described next and represented visually in Fig. 2.

3.1. Identifying the problem and defining objectives for a solution

We began by identifying and motivating the problem and defining the objectives for a proposed solution. As described in Sections 1 and 2, the design-implementation gap of SBMI exists in part because of a lack of appropriate tools for firms. At the same time, research has identified the general relationship between organizational design, dynamic capabilities, and SBMI, as well as the existence of common organizational barriers and drivers which can inhibit or assist with the development of the dynamic capabilities needed for effective SBMI. The objective therefore was to develop a tool which could help firms identify these barriers and drivers, therefore assisting firms in bridging the SBMI design-implementation gap. The process of identifying the problem and defining the objectives for a solution was informed not only by a review of the literature as outlined above, but also through conversations with academic experts. Further, we engaged in initial conversations with firms to gauge their interest in the development of such a tool. The level

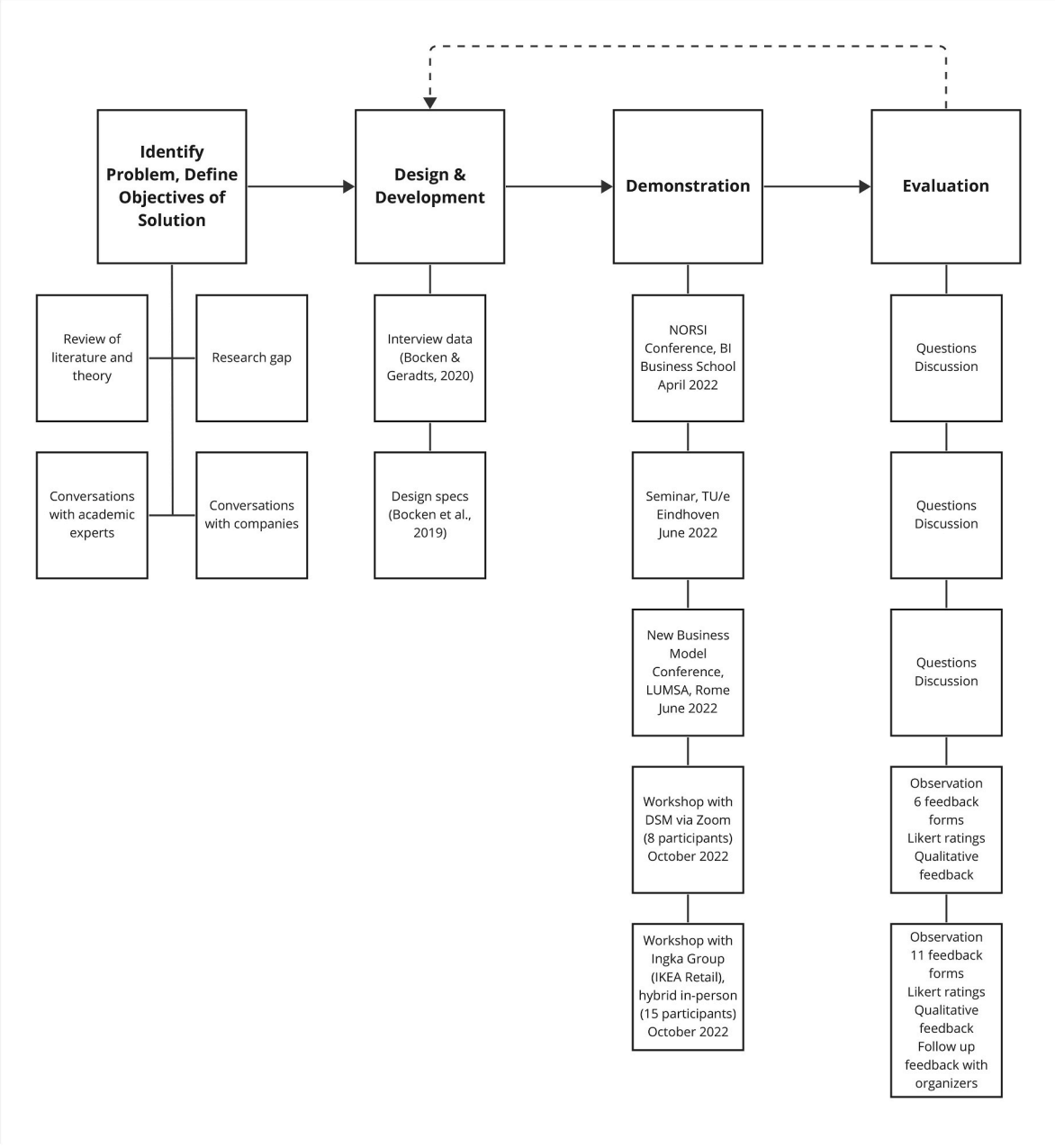

Fig. 2. Overview of the DSR method used in this research (adapted from Peffers et al., 2007; Baldassarre et al., 2020).

of interest from large firms was significant, confirming the presence of the problems identified in the literature and further motivating the development of a tool to address them.

3.2. Design & development

Once the problem had been identified and objectives defined, the first author designed an initial version of the tool which would eventually become the final tool and process, as depicted in Fig. 3. In designing the tool, we adhered to the design principles outlined in Bocken et al. (2019), as described in Table 1. The tool was purpose-made; rigorously developed from literature and practice; iteratively developed and tested with potential users; evaluated by users for effectiveness; provides a transparent procedure and guidance; incorporates broad sustainability objectives; is easy to use; triggers organizational change; and is adaptable to a variety of contexts.

The tool consists of three parts: the Barriers & Drivers Map (Fig. 4); the Culture, Strategy, and Operations Cards (Fig. 5), and the Design Grid (Fig. 6). These parts and the tool process are described in detail in Section 4.1. The tool is grounded in empirical insights from 56 interviews with top, senior, and mid-level management from 7 MNCs engaged in SBMI, including Philips, Unilever, AkzoNobel, Johnson & Johnson, and Pearson (Bocken and Geradts, 2020). Interviewees were asked to identify organizational factors that supported or inhibited SBMI processes. The analysis led to a list of 13 barriers and drivers, each associated with an organizational dimension, as shown in Fig. 1.

The barriers and drivers (Fig. 4) in the tool were derived from those presented in Bocken and Geradts (2020), with two important changes. First, 'institutional' barriers and drivers were relabeled as 'cultural' ones, to reduce jargon and make the tool more accessible and comprehensible for practitioners. Second, the 13 barriers and drivers were further distilled into nine pairs, following simplicity as a design principle and attempting to reduce overlap of barrier and driver content wherever possible. The content of the Culture, Strategy and Operations cards (Fig. 5) was derived by further distilling and simplifying interview data in Bocken and Geradts (2020), making aggregate responses easy for practitioners to understand and attempting to include tangible examples of how barriers and drivers can present in firm contexts.

While other approaches to thinking about organizational design could have been incorporated into tool development — for example, the hard structural aspects of organizational design related to business areas, functions, and management hierarchy — we opted to limit the tool to a focus on Culture, Strategy and Operations, following the guidance in Bocken et al. (2019) to keep the tool as simple as possible (Table 1).

Table 1
Tool design criteria from Bocken et al. (2019).

Tool Design Criteria	Application in Sustainable By Design tool
The tool is purpose-made	Focus on identifying organizational barriers and drivers for SBMI
The tool is rigorously developed—from literature and practice	Incorporating OD/DC/SBMI theory, deep empirical insights from interviews, input from expert audience, and tested in practice
The tool is iteratively developed and tested with potential users	Presented to three expert audiences and tested with two MNCs
The final tool version has then been used multiple times by practitioners, and an evaluation of this process is done to assess tool use and usefulness	Final tool tested by large MNC and received very positive quantitative and qualitative evaluations from participants
The tool provides a transparent procedure and guidance	Tool and workshop process are clear and grounded in robust empirics, as confirmed by user feedback
Circular economy or broader sustainability objectives and impact are firmly integrated	Barriers and drivers to SBMI in tool derived from challenges faced by some of world's largest companies
Simple and not too time-consuming	Simplicity was key design consideration: barriers and drivers were combined where possible and language simplified for practitioners
Inspires or triggers change	Tool aims to pave the way for fundamental shifts in organizational design in order to drive SBMI
Adaptable to different (business) contexts	Can be used at different levels within large organizations or for scale-ups that want to design for SBMI

3.3. Demonstration

The tool was first presented at two academic conferences and an academic seminar, attended by experts in sustainable business models, circular economy, innovation, and design (Table 2). Feedback was elicited to further confirm the theoretical grounding of the tool and attempt to refine its presentation for practitioners. We then utilized the

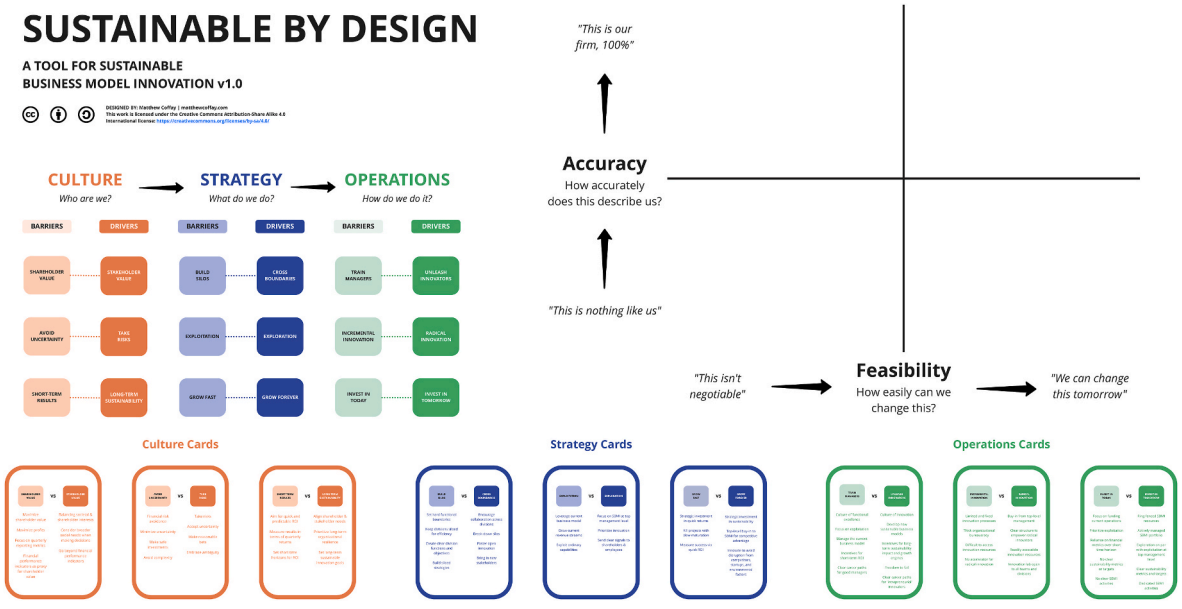

Fig. 3. The Sustainable By Design tool. The text is clearly visible on the Miro board where the tool is hosted: https://miro.com/app/board/uXjVOu7qLgQ=/

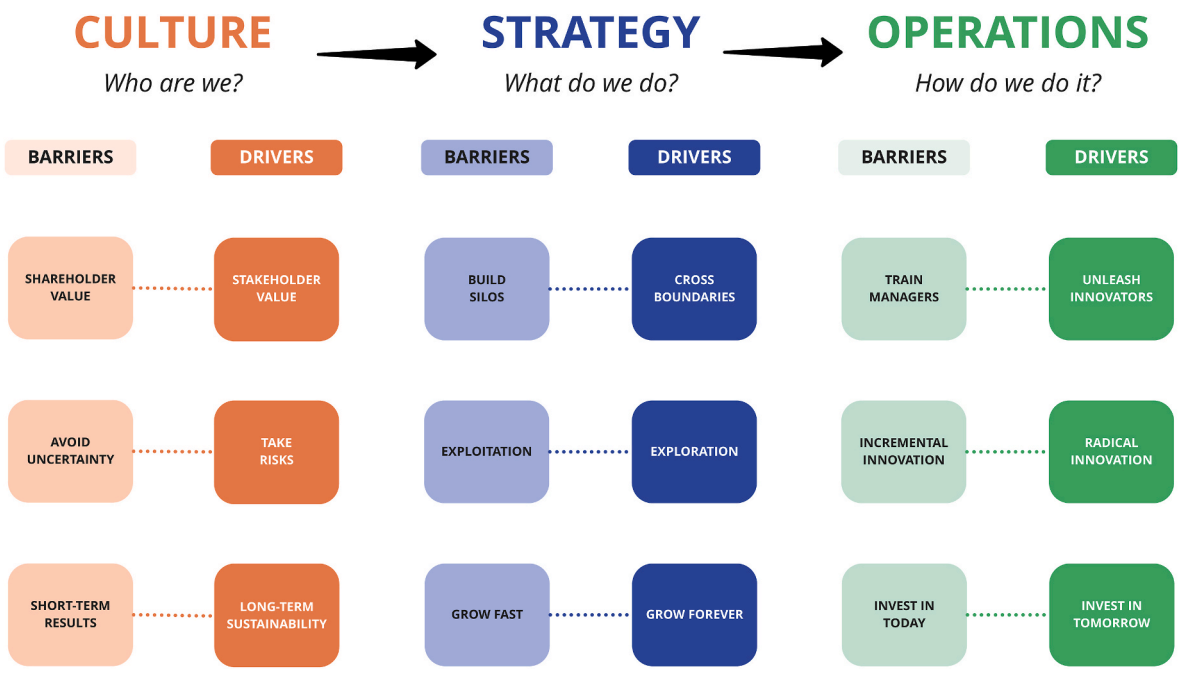

Fig. 4. Barriers & drivers map.

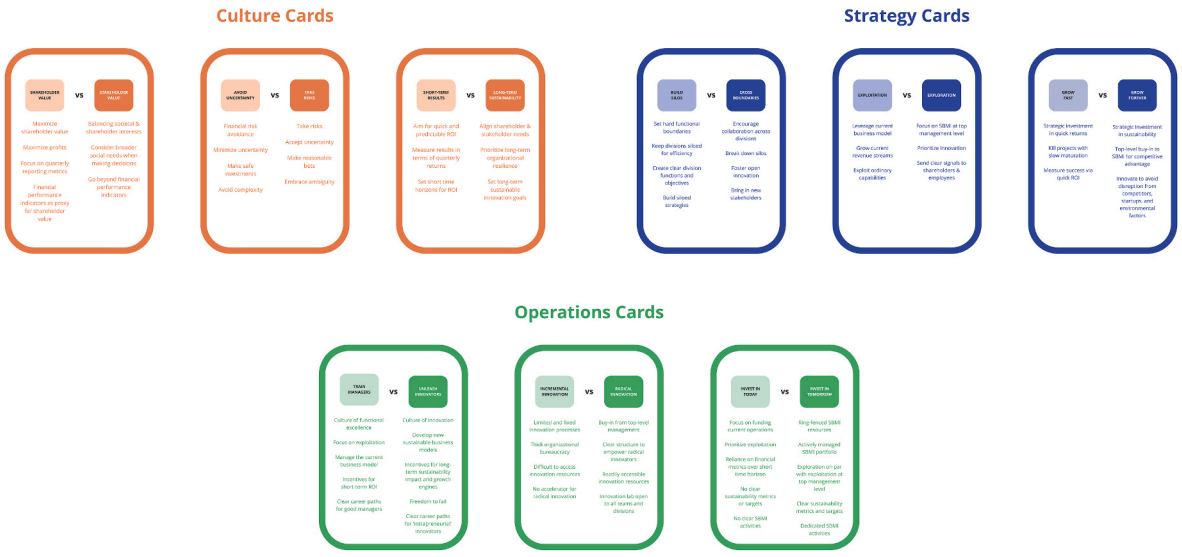

Fig. 5. Culture, Strategy, and Organization cards. The text is clearly visible on the Miro board where the tool is hosted: https://miro.com/app/board/uXjVOu7qLgQ=/

tool as part of two workshops with two firms seen as sustainability leaders in their respective sectors (DSGC, 2018; Globescan and Sustainability, 2020) (Table 2). The first workshop was with DSM, a Dutch multinational company which describes itself as "a global, purpose-led leader in health and nutrition, applying bioscience to improve the health of people, animals, and the planet" (DSM, 2022), and the second was with Ingka Group, the largest IKEA franchisee with 39.8 billion EUR revenue in 2021 (Ingka, 2021). DSM's strategy includes a focus on leveraging the company's "resources and capabilities to address the urgent societal and environmental challenges linked to the way the world produces and consumes food" (DSM, 2021, p. 4) and is "based on the global megatrends and the SDGs" (SDGs) (DSM, 2021, p. 7). IKEA aims "to inspire and enable the many people to live a better everyday life within the boundaries of the planet," with its business strategy based on the ambition to become more affordable, accessible and sustainable, including to become circular and climate positive by 2030 (IKEA, 2022). The DSM workshop was conducted via Zoom with 8 participants in addition to two facilitators (the authors). The IKEA Retail (Ingka Group) workshop was conducted hybrid, with 11 in-person participants on location in Malmö, 4 online participants, and one facilitator (the first author). The workshop process is described in detail in Section 4.1.

3.4. Evaluation

To evaluate the effectiveness of the tool, feedback was first elicited from academic experts in three different presentation sessions. This feedback was incorporated into the development of the workshop process, as detailed in Table 2. Further structured feedback was obtained from participants in the DSM and IKEA Retail (Ingka Group) workshops using online feedback forms which incorporated both quantitative and

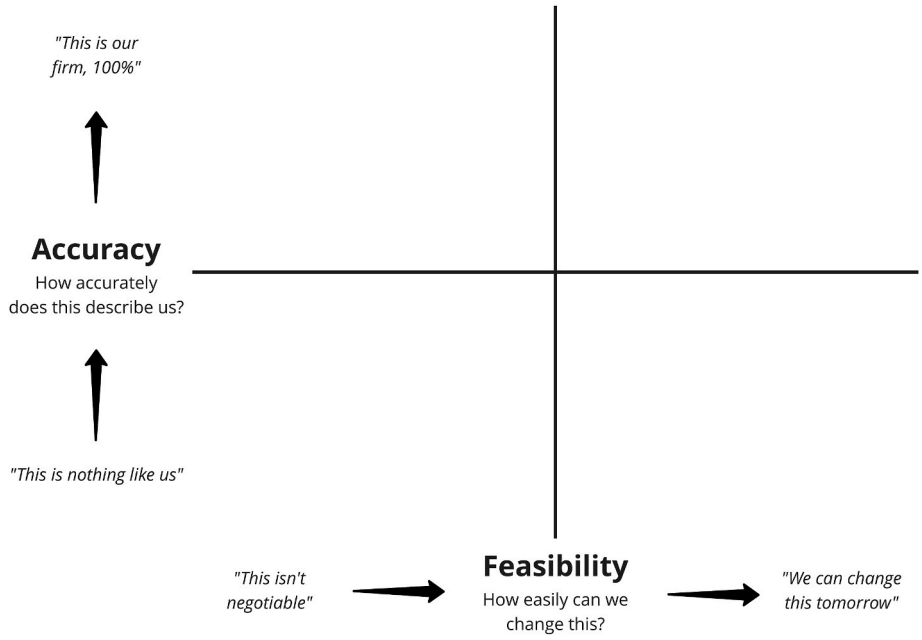

Fig. 6. Design grid.

Table 2
Workshops conducted for development of the tool.

#	Description	Date & Location	Participants	New elements added post-workshop	Steps in Fig. 2
1	Presentation at academic conference	Apr 22, 2022 BI Business School, NORSI conference Oslo, Norway	Academic: PhD students, academic researchers	No changes; validation of concept	Demonstration & Evaluation
2	Presentation at seminar	Jun 9, 2022 TU/e Eindhoven, Netherlands	Academic: PhD students, academic researchers	No changes	Demonstration & Evaluation
3	Presentation at academic conference	Jun 24, 2022 LUMSA University New Business Models Conference Rome, Italy	Academic: PhD students, academic researchers	Facilitation changes: Clear communication of sustainability elements in cards	Demonstration & Evaluation
4	Workshop with managers from different business areas of DSM (8 participants)	Oct 17, 2022 Online (Zoom)	Sustainability ambassador, portfolio managers, innovation directors	Facilitation changes: Guidance on next steps post-workshop, Clearer guidance on focus in breakout groups to eliminate confusion around overlapping content (Culture vs. Strategy vs. Operations), Longer and more frequent breaks in workshop process	Demonstration & Evaluation
5	Workshop with managers from sustainability, circularity, risk, compliance, strategy, and investment business areas of Ingka Group (15 participants)	Oct 25, 2022 IKEA Retail (Ingka Group) Malmö, Sweden	Circular strategy, sustainability managers/specialists/process leaders, ERM specialist, global ESG, circular leader	No changes	Demonstration & Evaluation

qualitative elements. The results of this feedback are detailed in Section 4.2 and presented in Table 3 (quantitative) and Table 4 (qualitative).

Table 3
Results from evaluation.

	Workshop 1 (DSM)	Workshop 2 (IKEA Retail (Ingka Group))	Overall assessment
How easy was the workshop to follow? *(mean & standard deviation)*	4.00 (0.89)	4.55 (0.69)	**4.35**
How useful was the workshop for you ? *(mean & standard deviation)*	3.67 (0.52)	4.18 (0.60)	**4.00**
Number of respondents and participants	6 (8 participants)	11 (15 participants)	

Feedback from academic researchers and PhD students indicated that the tool was "clearly needed." However, some expert seminar and conference participants suggested that the sustainability elements could be better clarified as part of facilitation (e.g., while sustainability elements are evident when reading the Cards, they are less clear when reading the abbreviated Barrier and Driver titles), and that next steps following the workshop should be discussed during the introductory session of the workshop. Some experts also indicated the importance of the tool's modularity, meaning its ability to fit into a variety of strategic sustainability processes across different firms.

4. Results

Below, we present the tool and workshop process which emerged following the design science research method, as well as a summary of quantitative and qualitative evaluation of the tool and workshop provided by workshop participants.

Table 4
Qualitative assessment.

Key takeaways	Suggestions for improvement	Actions
Robust methodology helpful for organizational design "Key to follow a robust methodology and process to surface real issues"	Explain next steps and follow up procedure	Discuss potential tools and workshops to follow up and take action on barriers and drivers (e.g. roadmapping)
The culture gap "Gap between what [we] say and what [we] actually want … how might we close that gap?" "The concept of actualized culture, to put a sticker on the main things that keep us away from what we aim to do" "We struggle to assess feasibility to change because there is a gap between what we say/our ambition vs reality"	Some content overlap between barriers and drivers across Culture, Strategy and Operations	During facilitation, remind participants to focus on Barriers and Drivers in each breakout session in terms of either Culture, Strategy, or Operations, depending on session
Risk aversion "How can we develop the risk appetite?" "the organization seems to be quite risk avert (sic) (in some areas)" "How can we collaborate more, allow more risks?"	More pre-read and prep material would help align participants beforehand	Consider sending out a survey pre-workshop to assess participant knowledge base and assign pre-reads as necessary
Differing views across business areas and silos "We have different perceptions on our … reality, depending on where we are working" "there is some heterogeneity across business groups and different ways to see the actual status" "bringing together of the different perspectives from the 3 breakout groups was hard"	More time for discussion in plenary sessions	Where possible, consider extending workshop from half day to three-quarters or full day to allow for more discussion in plenary

4.1. Final tool and workshop process

The Sustainable By Design tool (Fig. 3) was built in Miro, an online collaboration platform. We opted to design the tool in Miro for two reasons. First, the tool was designed during the COVID-19 pandemic, and we anticipated the need to conduct online workshops. Ultimately, one of the test workshops was conducted entirely via Zoom, while the other was held in a hybrid format. Additionally, we opted to build the tool in Miro to make it easy for practitioners to use the tool in the future by simply copying the tool to their own Miro board. The tool approaches SBMI at the level of organizational design, with the aim of aiding firms in developing the dynamic capabilities needed for SBMI. By identifying and mapping barriers and drivers to SBMI at the level of organizational culture, strategy, and operations, firms can take action to improve organizational design, boosting drivers for SBMI and breaking down barriers.

The complete tool is depicted in Fig. 3, with the component parts represented in Figs. 4, Figure 5, and Fig. 6. The tool can be accessed in Miro at the following URL: https://miro.com/app/board/uXjVOu7qLgQ=/. In a workshop setting, participants map out barriers and drivers for SBMI. Beginning with the Culture column, participants consider each Barrier-Driver pair, referring to the corresponding Card descriptions. For each pair, participants ask themselves: 1) Accuracy: how accurately does this describe our organization today? and 2) Feasibility: how easily could we change this? Next, participants map the Barrier-Driver pair on the Design Grid. Those barriers and drivers which are highly descriptive of the organization are placed higher on the Y (Accuracy) axis, while those which could most feasibly be changed are placed further to the right on the X (Feasibility) axis. This process is repeated for each Barrier-Driver pair, until all have been mapped onto the grid. At the end of the session, participants consider the Barriers in the upper-right quadrant (highly descriptive of the organization, feasible to change) and the Drivers in the bottom-right quadrant (not descriptive of the organization, feasible to change) (Fig. 7). These are the Culture, Strategy, and Operations components which should be addressed first for maximum impact on SBMI. Senior management can proceed to develop strategic interventions to address these barriers and drivers.

4.2. Evaluation of final tool and workshop process

Both workshops were evaluated with an anonymous online feedback form which included two Likert scale questions ("How easy was the workshop to follow?" and "How useful was the workshop for you?"), where participants could rate their experience from 1 to 5. Participants were also asked to elaborate on these responses. Evaluation of the final tool and workshop process was very positive, with participants scoring "How easy was the workshop to follow?" as 4.55/5, and "How useful was the workshop for you?" as 4.18/5 (Table 3). We noted a marked improvement in both Likert scale scores for these questions as well as qualitative response form feedback from the first workshop to the second workshop. In terms of usefulness, participants remarked in an open field for qualitative feedback that it was "really great to see that we can guide cross functional teams to insights and realizations in a democratic and co-creative way," and that the workshop process "gave a very good base for discussing the critical soft factors in a structured way." The tool was seen as enabling a "structure and common language for discussing barriers and drivers": one participant remarked that without the tool, "we could spend a lot of time discussing but not really moving or turning the 'complaints' into anything actionable." In terms of ease of following the workshop process, participants remarked that they "weren't confused even once," and that "the flow was very clear, and collaborative" with a "clear, simple structure."

In addition to the Likert scale questions above, workshop participants were asked to provide their key takeaways from the workshop along with any suggestions for improvement of the tool and/or workshop process. These key takeaways and suggestions are presented in a consolidated form in Table 4. The suggestions for improvement regarding content overlap were taken into consideration following Workshop 1 and incorporated into the facilitation procedure for Workshop 2. We noted that participants in Workshop 2 did not identify any issues or confusion regarding content overlap, and therefore consider our changes to have succeeded in addressing the issue raised by participants in Workshop 1. The increase in quantitative scores from Workshop 1 to Workshop 2 (comprehensibility, 4.0 to 4.55; usefulness, 3.67 to 4.18) strengthens this observation. While the other suggestions for improvement in Table 4 regarding follow up sessions, pre-reads, and additional discussion time were derived from Workshop 2 feedback, we consider the accompanying actions to be optional and 'nice to have' but not essential for successful workshop facilitation, based on the overall high scores and positive nature of the feedback from Workshop 2.

5. Discussion

This study investigated how firms can address organizational design issues in order to develop the dynamic capabilities necessary for sustainable business model innovation. We investigated the following question: How can firms address organizational design issues in order to develop the dynamic capabilities necessary for sustainable business model innovation? First, we reflect on the Sustainable by Design tool

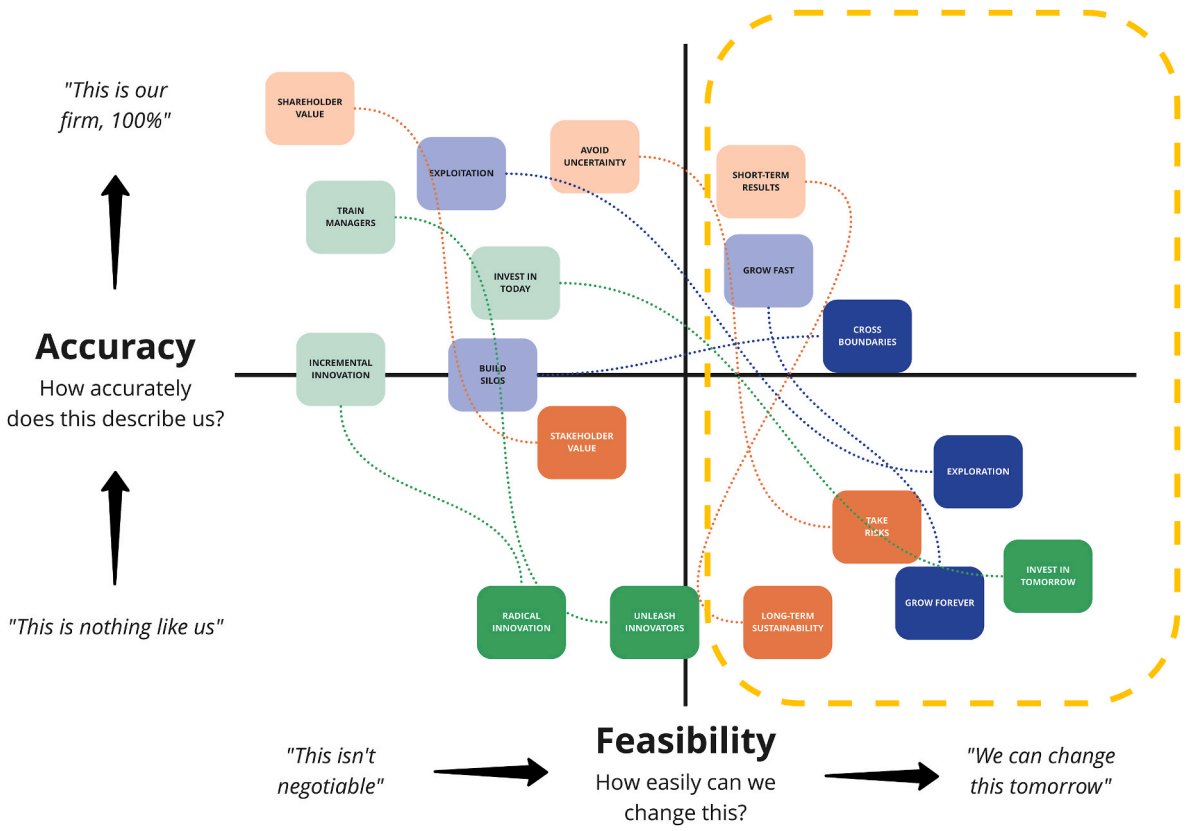

Fig. 7. Barriers and drivers mapped onto the Design Grid. High impact barriers and drivers inside dotted yellow line. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

developed in this study. This is followed by a discussion on the organizational design issues to develop the dynamic capabilities necessary for sustainable business model innovation, and future research.

5.1. Sustainable by design tool

Based on our experience and participant feedback, the Sustainable By Design tool appears to be useful for helping firms identify organizational barriers and drivers to develop the dynamic capabilities necessary for engaging in sustainable business model innovation. Below, we develop several lessons learned, which add to the emergent theory around how organizational design impacts dynamic capabilities for SBMI, drawing on participant feedback from the workshops as well as our observations during the workshop facilitation process.

First, we noted that there are often widely divergent views about which barriers and drivers are present depending on a participant's business unit, position within the organization, and background. While previous studies identified several (Bocken and Geradts, 2020; Hina et al., 2022), the action-based workshop approach illuminated real and contrasting opportunities and barriers at the organizational level. Participants noted that "we have different perceptions on our … reality, depending on where we are working," and that "there is some heterogeneity across business groups and different ways to see the actual status." This lack of consensus could lead to challenges with sensing and seizing opportunities for SBMI. Indeed, clarifying organizational vision is essential for sensing these kinds of opportunities. This was especially evident in the plenary sessions, in which breakout groups would attempt to reconcile their results with those of the other participants and achieve some consensus around where to place organizational barriers and drivers on the Map in plenum. We therefore suggest the following:

Lesson 1: Mapping organizational barriers and drivers to SBMI jointly with a tool and workshop process can help firms identify differing understandings, views, and visions across different organizational areas.

We further noted what we term a 'culture gap.' Many workshop participants observed that their organization's culture as communicated by top management was not always enacted at the level of operations. Hence, while research has highlighted design-implementation gaps at the level of developing and piloting circular and sustainable business models (e.g. Geissdoerfer et al., 2016, 2018; Baldassarre et al., 2020), this study identifies the need to address this issue already at the higher cultural level of the organization echoing earlier work by Geradts and Bocken (2019) on creating a culture for sustainable innovation. The ability to build this kind of organizational culture can itself be understood as a transformation-type dynamic capability, with Teece (2018) noting "realigning of culture" as an example of transforming (p. 44). Participants noted a "gap between what [we] say and what [we] actually want" and pointed to the "concept of actualized culture, to put a sticker on the main things that keep us away from what we aim to do." They further explained that the workshop helped them to see that they "struggle to assess feasibility to change because there is a gap between what we say/our ambition vs reality." Previous research has found that organizational subcultures can persist within a larger organization, with different subcultures maintaining different approaches to and understandings of sustainability (Linnenluecke et al., 2007). While Linnenluecke and Griffiths (2010) suggest that there could be a 'trickle down effect' from e.g. top management's emphasis on sustainability to lower levels of the organization, empirical studies have shown that this 'trickle down' rarely happens in practice (Harris and Crane, 2002; Howard-Grenville, 2006; Welford, 1995; Hoffman, 1993; Dodge, 1997). This leads us to the following:

Lesson 2: Organizations can suffer from a 'culture gap,' where top management's idealized views of company culture fail to trickle down to the operational level. Engaging in a structured assessment process with a tool like Sustainable By Design can help firms identify this gap and pave

the way for overcoming it.

Finally, we noted the value of approaching organizational design by leveraging an empirically grounded tool and workshop process. This is especially true in large organizations, where questions of organizational design can quickly devolve into vague, ungrounded, circular discussions without actionable outcomes. That these types of discussions might tend toward vagueness without the grounding of a tool and workshop process is unsurprising given the sweeping nature of organizational design and the wide range of definitions outlined in Section 2.2, in addition to the fact that it is still an emergent concept in the literature when connected with dynamic capabilities and SBMI (e.g. Inigo et al., 2017). Workshop participants noted that the tool provided them with "a structure and common language for discussing barriers and drivers to make discussion more concrete and to create a common base for developing our approach. Without this, we could spend a lot of time discussing but not really moving or turning the 'complaints' into anything actionable." They also commented that it is "key to follow a robust methodology and process to surface real issues," as was achieved with the workshop. Leveraging a tool like Sustainable By Design can itself therefore assist firms in developing transformation-type capabilities, e.g. for identifying internal incongruencies and realigning organizational culture (Teece, 2018). It can also provide firms with a process to follow in order to address organizational issues which can impede SBMI. This is important, as there is currently a lack of clear and testable processes for succeeding with SBMI. We therefore suggest one additional lesson:

Lesson 3: Organizational design is complex. For firms to effectively assess and take action on the Culture, Strategy, and Operations components of their organizational design, a structured process is important. This may be facilitated by a tool and workshop. Without such a structured approach, firms run the risk of dedicating time and resources to discussions which fail to materialize into actionable outcomes.

5.2. Organizational design to develop dynamic capabilities for sustainable business model innovation

Through the development of the Sustainable by Design tool based on literature, this study also gives new insight into the connections of organizational design to develop dynamic capabilities for sustainable business model innovation.

First, pressured by the increasing evidence on climate change, changing customer demands, and emerging legislation, sustainable business model innovation becomes a corporate solution to tackle societal and environmental issues by transforming the way business is done (Bocken and Konietzko, 2022; Schaltegger et al., 2012; Stubbs and Cocklin, 2008). Through the workshops we conducted as part of the tool development process, it emerged that companies with bold sustainability visions realize that more radical sustainable business model innovation is needed, e.g. offering second hand products or product as a service models. To successfully implement and embed new business models in the organization, organizational design needs to be adapted (Teece, 2018). Despite the bold sustainability visions and sustainable business model experiments, organizational design lags behind. This results in tension, as the existing organizational design is primarily fit for the current 'unsustainable model' and may not be suited to encourage sustainability throughout the organization. For example, in the move from a linear to a circular business model, companies may not have the logistics capabilities, physical space in stores, or incentives to implement circular business models at scale. While the Sustainable By Design tool highlights key challenges and ways to overcome them for organizations, deeper organizational work is needed to address business model and organizational design challenges in parallel.

Second, echoing earlier work (Slawinski et al., 2017), organizational (in)action manifests at the cultural, strategic and operational layers. For a sustainable business model innovation to be successful, the organizational design needs to be supportive at all levels. For example, top-level commitment needs to be matched with KPIs and incentive schemes at the operational level, while teams must be given room to experiment (Bocken and Geradts, 2020). To illustrate, a circular economy vision without secondhand or remanufactured sales targets will hardly be successful. The Sustainable By Design tool applied collaboratively in cross-functional teams revealed that these challenges are real and urgent, and suggest there could be a role for 'sustainable organizational designers' to orchestrate the changes to make the business ready for sustainability challenges. Hence, while corporate sustainability and innovation teams are working on product and sustainable business model innovations, there may be a new role for 'organizational redesigners' for sustainability who start to realign the organization design elements to gradually shift to a more sustainable business model. While such a role is now often conducted by external consultants, this study showed the importance of organizational design for sustainability and a potential core role of internal organizational designers for sustainability.

Third, significant work in research and practice has gone into making organizations agile to respond to a VUCA world resulting from growth in digital innovation and global challenges (Schoemaker et al., 2018; Worley and Jules, 2020). Echoing Worley and Jules (2020), we see that sustainability challenges require a new form of agility to address quickly changing environmental pressures, climate change and resource pressures, geopolitical changes, and shifting customer demands and legislation (e.g. the EU Circular Economy Action Plan). As Worley and Jules (2020) argue: "there is no sustainability without agility" (p. 279). The Sustainable By Design tool developed in this study could serve as a starting point to judge organizational readiness for sustainability challenges, and in particular embedding sustainable business model innovations. However, future work can identify synergies between organizational design for sustainability and dominant research and practice in areas like organizational agility and lean organizing (e.g., Benkarim and Imbeau, 2021; de Freitas et al., 2017).

5.3. Limitations and future work

The study's main limitation is the sample of two corporations. While these corporations are seen as leading in sustainability in their fields, a greater number of workshop sessions would have revealed more patterns of how organizational design might hinder or drive sustainable business model innovation.

Future work might further explore the connections between organizational design, dynamic capabilities, and SBMI. It could delve deeper into the organizational design needs and challenges at different levels in large organizations, including the cultural, strategic and operational levels (Slawinski et al., 2017; Bocken and Geradts, 2020). Further research could also explore the role of a 'sustainable organizational designer' as an internal change agent within an organization, tasked with connecting sustainable business model innovation with the organizational changes needed to succeed with new business model implementation and organizational transformation. Additionally, future research could explore various synergies between work on agile and lean organizational design on the one hand (e.g. Benkarim and Imbeau, 2021; de Freitas et al., 2017; Worley and Jules, 2020) and, on the other, organizational design to develop the dynamic capabilities needed for SBMI — that is, how companies might become 'sustainable by design'.

Action research case studies and design science research can be fruitful approaches to both further developing the body of theory in this area while also making positive contributions to the transition toward more sustainable forms of production and consumption. In particular, researchers could further investigate cultural misalignment around sustainability within an organization, and how internal subcultures can realign to drive sustainability outcomes specifically related to SBMI. Another fruitful avenue for research involves the *process* needed to succeed with SBMI. We have suggested that not only a lack of good tools, but also a lack of a clear process can lead to a failure to bridge the design-implementation gap of SBMI. Starting by addressing organizational design considerations first — particularly the barriers and drivers which

exist at the cultural, strategic, and operational levels in an organization — can serve as the first step in a process to achieve better SBMI outcomes. Future research could investigate this process further.

6. Conclusion

Companies across different industries need to transform their largely unsustainable business models to sustainable business models. This requires a radical reorganization of businesses and how they operate. In this paper, we investigated how firms can address organizational design issues to develop the dynamic capabilities necessary for sustainable business model innovation. Leveraging a design science research methodology, we developed the 'Sustainable By Design' tool which was used in a workshop setting with two large multinational companies seen as sustainability leaders in their sectors: DSM and IKEA Retail (Ingka Group).

This study made two contributions to the literature. First, we developed the Sustainable by Design tool which practitioners can use to evaluate their current organizational design, identify barriers and drivers for SBMI, and subsequently develop strategic interventions to engage in organizational transformation. This tool is grounded in theory and empirical research, and has been validated in practitioner contexts. Additionally, we made a contribution to the body of theory around the connections between organizational design, dynamic capabilities, and sustainable business model innovation. Our research further confirms the importance of these connections. We observed that when leveraging a tool and workshop process to address organizational design for SBMI, visions and understandings of organizational barriers and drivers often differ across business areas. Further, organizations can suffer from a 'culture gap', where top management's idealized views of company culture fail to trickle down to the operational level (Linnenluecke and Griffiths, 2010). A tool like Sustainable By Design can help teams identify and reconcile internal incongruencies between organizational subcultures, providing them the opportunity to realign and prioritize sustainability outcomes. Additionally, organizational design is complex, and addressing organizational barriers and drivers for SBMI may be best achieved with a structured and empirically robust approach (e.g. leveraging a tool such as Sustainable By Design) to keep discussions focused and actionable. Taking action to mitigate barriers and boost drivers must then be a priority of leaders with an organization. We further found that organizations may need to engage in deep organizational design work in order to succeed with implementing new, sustainable business models at scale. Such work may entail the need for new company roles focused on organizational design for sustainability. Mounting sustainability challenges presented by a VUCA world may demand new agile organizational forms better suited to adaptation and sustainable innovation.

Funding

This work was supported by a PhD scholarship at the Department of Business Administration, Western Norway University of Applied Sciences; European Union's Horizon 2020's European research Council (ERC) funding scheme [850159], Project Circular X (www.circularx.eu).

CRediT authorship contribution statement

Matthew Coffay: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Funding acquisition. **Nancy Bocken:** Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Funding acquisition.

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.

Data availability

The data that has been used is confidential.

Acknowledgments

Many thanks to those who participated and offered feedback at the conferences, seminars, and workshops where the tool was developed and tested. Special thanks to Hege Sæbjørnsen, Miya Allen, and Martijn Antonisse for their assistance in organizing the company workshops.

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