



Effectuated sustainability: Responsible Innovation Labs for impact forecasting and assessment

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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.

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 (Saravathy, 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 innovation² 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 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)” (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 planning.

- 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

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.

‘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

is worth noting that effectuation and experimentation are distinct processes which can and should complement one another — 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

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

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.

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

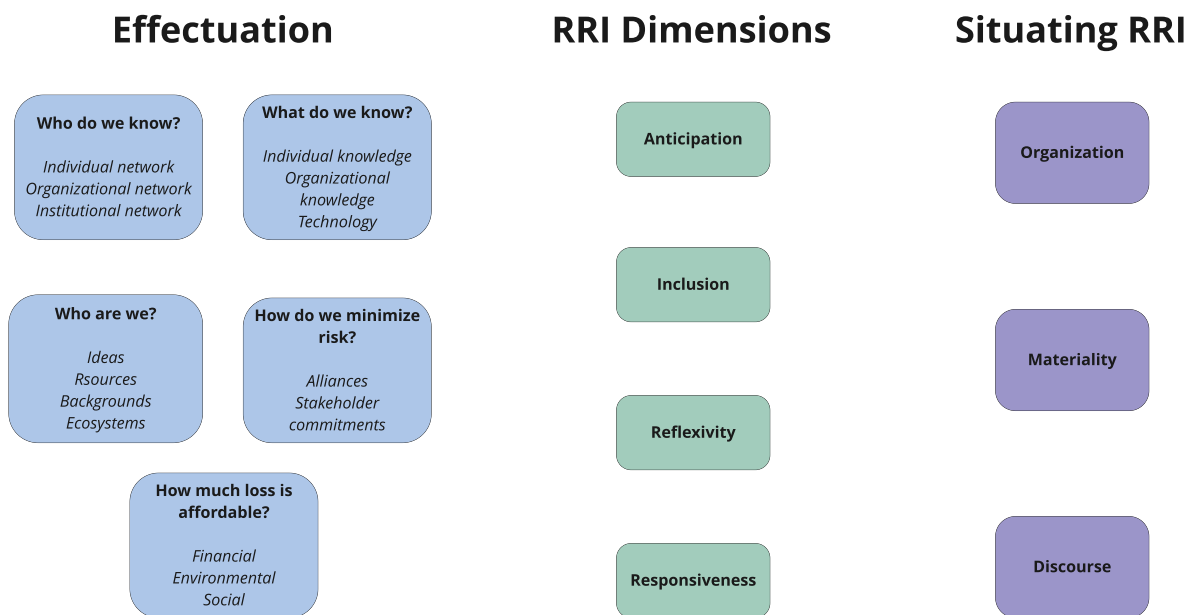


Fig. 1. Combining effectuation theory and RRI to develop the Responsible Innovation Tool (Fig. 2) and Responsible Impact Tool (Fig. 3).

Responsible Innovation Tool

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

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

Responsible Impact Tool

	Impact Forecasting	Impact Assessment	Impact Action
Anticipate	<i>Where can we create opportunities for impact? What do we bring to the table as organizations and individuals?</i>	<i>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?</i>	<i>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?</i>
Include	<i>Who are we including in this process? Where are there knowledge gaps? Where can we form new alliances and bring in new talent?</i>	<i>What stakeholders are responsible for impact assessment? Who is excluded? How do we navigate conflicts and foster inclusion?</i>	<i>Which key stakeholders should we include in taking action for impact?</i>
Reflect	<i>How much flexibility exists with our approach to impact forecasting? Are we locking ourselves in? Are we stuck in causal thinking?</i>	<i>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?</i>	<i>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?</i>
Respond	<i>What opportunities are emerging as we collaborate? How can we create space to identify, co-create, and seize new impact opportunities?</i>	<i>How can the method of impact assessment adapt and shift when new impact opportunities emerge? Is there lock-in?</i>	<i>How can we leverage new insights gained from forecasting and assessment processes to drive action?</i>

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 Sarasvathy’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 granted⁷ — 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.

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