



Challenges and dilemmas in strategic urban experimentation An analysis of four cycling innovation living labs

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ABSTRACT

Living labs have emerged as a form of strategic urban experimentation in sustainability transitions governance among policy makers and researchers. Limited attention has been given to the various challenges and dilemmas when doing LLs in relation to enabling urban transitions. This paper unpacks 16 challenges and dilemmas that arise for different actors in the process of living lab experimentation. The paper combines theoretical insights from Strategic Niche Management literature and insights from transdisciplinary research on living labs with empirical data from a qualitative case study analysis of four cycling innovation living labs in the Netherlands. By contrasting challenges and dilemmas identified in literature and those derived from our data, we reflect on key gaps between conceptual aspirations and empirical realities of strategic urban experimentation in sustainability transitions.

1. Introduction

Urban experimentation and living labs (LL) have been heralded in sustainability transitions literature as a way to trial, learn from and govern socio-technical innovations and urban transformations in cities to address local sustainability challenges (Bulkeley et al., 2016; Voytenko et al., 2016). We refer to such initiatives as ‘strategic urban experimentation’. We consider experimentation ‘strategic’, because it is intended to enable exploration and learning about long-term challenges, uncertainties and ambiguities in short-term projects. Navigating experimentation and innovation in cities is a complex endeavor (Hommels, 2005). Unlike traditional laboratories, cities lack ability to fully control conditions in which innovations can be researched and tested (May and Perry, 2016). Cities are characterized by diverse local challenges, multiple stakeholders, multilevel-interdependencies, technological uncertainty and fragmented decision-making. In response, LLs — as a new and open way of governing socio-technical experiments in cities aimed at cocreation — have received much attention in academic and policy spheres (Evans et al., 2016; Turnheim et al., 2018).

Research on strategic urban experimentation in urban sustainability transitions is increasing (Marvin et al., 2018). Literature has addressed the design of LLs (Bulkeley et al., 2018; Voytenko et al., 2016), favorable

contextual conditions for experimentation (van den Heiligenberg et al., 2017), and scaling up, broader impacts and socio-spatial embedding (Frantzeskaki et al., 2018) or institutionalized (Raven et al. 2019). The sustainability transitions research agenda calls for more attention to conditions, processes and pathways through which urban experimentation emerges (Köhler et al., 2019). Our starting point here is that challenges and dilemmas of LL experimentation are discussed only to a very limited extent in this literature (Hossain et al. (2019)). It is pertinent for living labs to learn about what works and what does not over time, and yet monitoring and evaluation required to make this happen often attracts less budget (Evans, 2015; Von Wirth et al., 2019).

We undertake long-term analysis “from within” four strategic urban experiments in the Netherlands. This provides insight into how strategic urban experiments unfold and evolve, what sort of practical challenges emerge in and through strategic urban experimentation, and how these are navigated. Our research question is: *what are challenges and dilemmas in doing strategic urban experimentation?* To answer this question, four LLs in four cities in the Netherlands are closely followed over a period of three years – from the selection of an experiment to implementation. We combine Strategic Niche Management (SNM) literature with insights from transdisciplinary research in living labs to develop a tentative framework of challenges and dilemmas

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Section two reviews relevant literature and builds the framework. Section three outlines the research design and empirical background. Section four presents empirical insights from the four cases. Section five discusses similarities and differences between the insights derived from the literature and the empirical insights. We explore how and why challenges and dilemmas are similar or different across the cases, with reference to differences in place-specific conditions. Section six concludes and discusses implications of this research for research and practice.

2. Experimentation: challenges and dilemmas

This section builds a framework for identifying challenges and dilemmas in strategic urban experimentation.¹ We adopt the following definition of an experiment in sustainability transitions: *‘an inclusive, practice-based and challenge-led initiative, which is designed to promote system innovation through social learning under conditions of uncertainty and ambiguity’* (Sengers et al., 2019). Urban LLs can be considered a sub-set of the general definition above in the sense that urban LLs are set within urban contexts, aim to transform urban (infra)structures, are performed particularly by urban actors and aim to resolve urban challenges.²

SNM is a well-established approach in experimentation literature, which conceptualizes experimentation as a strategic approach to niche creation and provides guidelines to set up and manage experiments (Schot and Rip, 1997). SNM research emphasizes three key processes of experimentation: articulation of expectations and visions, building of social networks and learning processes (Berkhout et al., 2010; Kemp et al., 1998). SNM suggest to design and manage experiments in such a way that they contribute positively to these three processes, which in turn will lead to establishing market niches, and eventually contribute to transforming incumbent socio-technical regimes. Later, focus in SNM shifted from individual experiments to series of experiments (e.g. Geels and Raven, 2006; Raven, 2005). Again later, SNM research explored how socio-technical innovations can move from niche level to the socio-technical regime by asking questions about niche-regime interactions (e.g. Raven, 2006; Smith, 2007; Smith and Raven, 2012). In this research we are interested in what happens at the level of individual experiments (the ‘local level’ in Geels & Raven (2006) rather than dynamics at the level of niches (the ‘global level’ in Geels & Raven (2006)). While it would be interesting to also explore challenges and dilemmas of niche development, this is outside the scope of the paper, and would require longer time frames than we have access to, given that niche development is a process routinely identified over a 10–15 year period.

In the remainder of this section, each process is discussed in more detail, i.e. what is it about, why it is important and what do we already know about potential challenges and dilemmas of these processes in practice from literature. Based on a Scopus literature search, 52 articles were identified about SNM processes, which will provide the basis for our literature review. See Appendix A for the details on the method of this literature search. The SNM literature has been enriched with insights from additional relevant writings on LLs, and in particular from recent studies on transdisciplinary challenges and dilemmas related to

¹ This distinction is based on definitions from Cambridge Dictionary. We define a challenge by a situation being faced with something that needs (great mental or physical) effort in order to be done successfully (and therefore tests a person’s ability). We view dilemmas as circumstances in which a difficult choice has to be made between two different things you could do.

² We note that not all urban LLs might be challenge-led. This particular characteristic was derived from a systematic review of experimentation in the context of sustainability transitions (Sengers et al., 2019). Urban LLs on the other hand may in fact also be established for other reasons, such as economic opportunities to attract foreign investment, or as part of city marketing purposes.

transdisciplinarity. These studies were identified by following up on references as well as expert knowledge available in the author team and reviewer feedback. Table 1 provides an overview each concept and related challenges and dilemmas identified in the literature. In the discussion section we reflect on this methodology and its implications for future work.

2.1. Visions and expectations

In early stages of socio-technical innovation, benefits are often not evident and its value has yet to be proven. Interested actors articulate promises and create expectations to provide direction to learning processes, attract attention and legitimate protection and nurturing (Weber et al., 1999; Geels, 2012).

From the literature two distinct challenges, related to visions and expectations, are identified. The first is a lack of a vision or concrete expectations about the socio-technical innovation. This results in a lack of direction to learning and does not allow to attract attention (ibid). The second challenge is to ensure and create robust expectations. Non-robust expectations – not shared among stakeholders— hamper strategic experimentation, because they reflect varying dispositions about the future of a socio-technical innovation, which limits capacity to collectively drive developments. Underlying these non-shared expectations are often different understandings or interpretations of the innovation and its (future) contexts of application. Studies show examples of how different interpretations of smart grids (Naber et al., 2017), eco-industrial parks (E Susur et al., 2019) or district heating (Bush et al., 2017) hindered strategic experimentation.

SNM literature also reveals three dilemmas related to visions and expectations. The first is a broad vs specific vision about the experiment. Research showed that visions should be broad enough to allow for multiple solutions, but at the same time, specific enough to offer plausible promises to stakeholders to gain credibility (Weber et al., 1999). Selecting a socio-technical innovation for experimentation and at the same time trying to avoid lock-in and path dependency, is one of the main dilemmas in SNM (Kemp et al., 1998). A bold vision, will mobilise a great variety of stakeholders, however, if it is too broad or general it does not provide clear guidance (Lente, 1993; Schot and Geels, 2008). The second dilemma is the attitude towards this vision. A flexible attitude allows for learning, adjusting visions to circumstances and taking advantage of windows of opportunity, but risks to dilute visions to a point where they are no longer transformative. A persistent attitude may impede flexibility, but enables a more consistent approach that maintains the transformative potential of the experiment (Schot and Geels, 2008). The third dilemma concerns too high expectations versus too low expectations. Making high promises early on to attract attention and funding can trigger enthusiasm for some time, but can subsequently be followed by disappointing results and the need for adjusting expectations (Verbong et al., 2008). Thus, expectations should be credible and of high quality i.e. supported by facts, tests and ongoing projects.

Similar observations have been made in transdisciplinary approaches in relation to urban experimentation. Challenges and dilemmas include overcoming conflicting stakes, priorities, expectations or problem definitions in transdisciplinary research (Culwick et al., 2019; Hessels et al., 2018; Scholl et al., 2018). Jahn, Bergmann, & Keil (2012). Lang et al., (2012) and Hessels et al., (2018) argue that a defining feature of transdisciplinary research such as urban experimentation is the challenge of integrating different bodies of knowledge (epistemic level), different interests (socio-organizational level) and establishing a common language that advances mutual understanding (communicative level). In fact, such differences are likely to inform contrasting expectations about what a living lab is about or should serve.

2.2. Social network building

Social network building, collaboration and forging alliances are

Table 1
Challenges and dilemmas derived from the SNM literature.

Process	Challenges and dilemmas identified in literature	Reference
Vision and expectations The articulation of expectations and the creation of visions is an important process in establishing an experiment as it provides directions to learning processes, attracts attention and legitimates protection and nurturing.	Challenge	1. Create a vision and/or concrete expectations (Hatzl et al., 2016), (M Jain et al., 2017), (Wolfram, 2018), (Elmustapha et al., 2018), (Ebru Susur et al., 2019) 2. Ensure robust visions and expectations (Weber et al., 1999), (Weber, 2003), (M C J Caniëls and Romijn, 2008), (Ceschin, 2013), (Xue et al., 2016), (Naber et al., 2017), (Bush et al., 2017), (Imbert et al., 2019), (E Susur et al., 2019)
	Dilemma	1. Broad vs specific experiment (Kemp et al., (1998)(Weber et al., 1999) 2. Flexible vs persistent attitude towards vision (Schot and Geels, 2008), (Hatzl et al., 2016), (Turnheim and Geels, 2019) 3. Too high vs too low expectations (Verbong et al., 2008), (Marjolein C.J. Caniëls and Romijn, 2008), (Verbong et al., 2010), (Seyfang and Haxeltine, 2012), (Heiskanen et al., 2015)
Network, actors and resources Network building is important to create support for the new socio-technical innovation, facilitate stakeholder interaction and provide necessary resources.	Challenge	1. Building broad networks (Weber, 1999), (Weber 2003), (Schot and Geels, 2008), (Verbong et al., 2008), (Hoppe et al., 2015), (Xue et al., 2016), (Naber et al., 2017), (Verbong et al., 2010) (Hatzl et al., 2016), (Naber et al., 2017) (Verbong et al., 2008) 2. Enabling deep networks 3. Navigating network tensions 4. Generating public acceptance and support (Verbong et al., 2008) 5. Organizing leadership and/or local coordination (Seyfang et al., 2014), (Hoppe et al., 2015), (Bush et al., 2017), (van der Grijp et al., 2019)
	Dilemma	1. Incumbents vs challengers (Weber et al., 1999) 2. Dependency vs autonomy (Weber et al., 1999), (Seyfang et al., 2014) (Kemp et al. 1999)
Learning Broad learning, encompassing first order and reflexive learning processes.	Challenge	1. Facilitate reflexive learning (Weber et al., 1999), (Wiskerke, 2003), (Schot and Geels, 2008), (Reeger, de Wildt-Liesveld, van Mierlo, & Bunders, 2016), (Naber et al., 2017), (Wolfram, 2018), (Elmustapha et al., 2018) (Heiskanen et al., 2015) 2. Aligning learning goals across organizations

Table 1 (continued)

Process	Challenges and dilemmas identified in literature	Reference
	3. Learning across experiments	(Seyfang et al., 2014), (Heiskanen et al., 2015) (Luederitz et al., 2016), (Weber et al., 1999), (Weber, 2003), (Schot and Geels, 2008), (M C J Caniëls and Romijn, 2008), (Verbong et al., 2008), (Huijben & Verbong, 2013), (Hatzl et al., 2016), (Bush et al., 2017), (Bush & Bale, 2019), (E Susur et al., 2019)
	Dilemma	1. Enabling broad learning (M C J Caniëls and Romijn, 2008), (Verbong et al., 2008), (Schot and Geels, 2008), (Verbong et al., 2010), (Hatzl et al., 2016), (Mansi Jain et al., 2017), (van der Grijp et al., 2019)

among the key factors for setting up an experiment because it is important to create support for the socio-technical innovation, facilitate stakeholder interaction and provide necessary resources (e.g. time, money, people, expertise) (Berkhout et al., 2010). SNM literature distinguishes between local and global actor networks: local networks consist of actors who work on a specific experiment, whereas global networks consist of actors who have some distance to the experiment, but are related through providing resources such as financial or political support, technical specification and by generating a space in which local actors work. At this global level, abstract, generic knowledge is shared within the (emerging) community. At the local level, specific knowledge, skills, hands-on-experiences and practices are generated (Geels and Raven, 2006).

Extant literature shows five challenges and two dilemmas in creating a network for successful experimentation. The first challenge is to facilitate and create a broad and diverse network. Narrow and closed networks are challenging because they do not include a variety of stakeholder perspectives which leads to limited learning possibilities. Particularly, user involvement is important for socio-technical experimentation (Weber et al., 1999). Second, a challenge is how to enable a deep network with relevant and committed actors. In a deep network stakeholders are able to mobilize commitment and resources within their organization (Schot and Geels, 2008; Weber et al., 1999). Lack of a deep network can impede experimentation because it affects access to necessary resources. A third challenge is to create a harmonious network and to navigate tensions between actors. Networks are not always be harmonious. Internal tensions between network members pose challenges for experimentation. For example, governments' and technology developers' views may clash, which damages willingness to cooperate (Verbong et al., 2008). Navigating tensions and overcoming different views contribute to achieving valuable outcomes. A fourth challenge is to generate public acceptance around the experiment. For instance, although renewable energy in general is widely supported, specific options in particular locations can be contested. This can lead to protest and resistance to an experiment (Verbong et al., 2008). A fifth challenge is to organize leadership and local coordination of the experiment (Seyfang et al., 2014). Limited leadership or management of the experiment hampers continuity.

A network-related dilemma is engaging with 'regime' insiders (the status quo) versus outsiders. Including relative outsiders broadens visions and allows for 'radical' ideas whereas vested interests hinder innovation, even though working with incumbents enables access to resources and competences (Weber et al., 1999). The second dilemma

relates to resources and concerns dependency vs autonomy. Support and access to resources (e.g. social, human, political, organizational and financial) is crucial as it helps to protect experimentation from too early rejection in mainstream markets. However, a balance must be struck between too much and too little protection. Support and protection can be of crucial importance in order to give an experiment legitimacy and stability in the start-up phase. On the other hand, reliance on protection may weaken autonomous learning processes (Hommels et al., 2007).

Similar types of challenges and dilemmas are identified in studies on transdisciplinary approaches. As transdisciplinary research involves collaboration between scientific disciplines and collaboration between science and society actors (Jahn et al., 2012), building a diverse network of engaged actors is key. However, insufficient legitimacy of actors involved, unbalanced problem ownership and limited capacity to engage in transdisciplinary research collaborations is challenging (Hessels et al., 2018; Lang et al., 2012). For urban labs, the mode of working of academics can undermine the ease of non-academics to participate (Culwick et al., 2019). In addition, Scholl et al., (2018) show that a challenge for urban labs is to have linkages with formal government structures to facilitate embedding lessons learned into practice.

2.3. Learning

Learning processes are important for experimentation as they enable the generation of knowledge about needs, problems and possibilities of the innovation (Kemp et al., 1998).³ Literature discusses one dilemma and four challenges related to learning. A dilemma is to enable broad learning, i.e. learning that is focused on aligning lessons about technical (technology, infrastructure) and social aspects (e.g. user context, markets, policy, regulation, societal impact) (Van der Laak et al. 2007), without watering down focus. In practice, learning in experiments is often focused too much on technological or economic aspects. On the other end of the dilemma, however, is the observation that when experiments are designed with too many learning ambitions in mind, choices and commitments are hampered or delayed (Schot and Geels, 2008).

The first challenge is to facilitate reflexive learning, i.e. learning that challenges deeper held values, beliefs and assumptions (Schot and Geels, 2008). Through such learning, fundamental conceptions about technology, users, demands and regulations are questioned and explored. It may lead to changes in cognitive frames, underlying assumptions and ways of looking at problems or solutions (Hoogma et al., 2002). Reflexivity requires trust and engagement through interaction and dialog. Reflexive learning is enabled by continuous evaluation of experiments and learning across experiments, but this is often challenging in practice, e.g. because of a lack of resources for monitoring, a lack of clear responsibilities, political need to demonstrate success, or a lack of reflexive capabilities.

A second challenge is to align learning across organizations with different learning goals. Varying learning goals stand in the way of fruitful experimentation. For some stakeholders, learning might be a secondary rather than a primary goal. They rather make concrete achievements than learn about possibly unfeasible options (Heiskanen et al., 2015).

A third challenge is to facilitate learning across different experiments. Learning across different experiments helps foster sustainability transitions (Luederitz et al., 2016). However, in transferring and applying generic knowledge to specific contexts, local networks often need help and support to translate those lessons into their specific contexts. Learning from experiments — transforming outcomes into generic lessons — requires dedicated ‘aggregation activities’ (e.g. standardization, codification, model building, formulation of best practices) and circulation of knowledge to enable comparison between local practices (e.g. conferences, workshops, technical journals, proceedings,

³ Hoogma (2002) identified five learning dimensions: technical development and user infrastructure, user context, societal and environmental impact, industrial development and policy and regulations (see Jain, 2017).

newsletters) (Geels and Raven, 2006). However, stakeholders can be reluctant to share data and insights across the network, for example due to a lack of trust or competition.

In line with the abovementioned challenges and dilemmas, studies on transdisciplinarity also stress the importance of reflexivity about learning and the role of researchers (Jahn et al., 2012). In the context of urban experimentation, Scholl et al., (2018) found that a lack of clear and shared focus on learning about new forms of governance can be a key challenge, as well as, too much focus on operational issues rather than capturing lessons learned. Transdisciplinary approaches aim at enabling mutual learning between science and society. However, being an engaged researcher can be challenging as one has to maintain some critical distance (Wickson et al., 2006). To be able to work with these potentially conflicting agendas, actors should ‘nurture reflexive research habits’. For urban experimentation, this means that a key challenge is learning goals should be aligned and that the position of researchers may influence LLs.

3. Research design

This research is embedded in a transdisciplinary research project running from 2016 to 2020.⁴ The project explores cycling innovation in the context of sustainable mobility transitions and livable urban regions. Strategic urban experiments in four cities were established in a transdisciplinary manner (te Brömmelstroet et al., 2020). The research design is exploratory. We aim to determine particular aspects of a phenomenon, in our case challenges and dilemmas in living labs, where we have (some) control over behavioral events (through co-creation of the labs), with a focus on contemporary events. Our case study strategy is a mix of what Yin (2003) terms an ‘experiment’ and ‘case study’. Because our cases are situated in the same national context, but within different local and regional context, we characterize our research strategy as a multiple-case study design, which allows us to contrast the findings on the basis of key concepts in our framework.

3.1. Case study characterization

The cases of this study are four LLs, described in box 1.

The cases are situated in the Netherlands, where cycling rates are high, although different per city. In Amsterdam (821.752 inhabitants) the share of cycling in transport use is 36%; in Utrecht (334.176) it is 41%; Eindhoven (223.209) it is 33% and in Zwolle (123.861) it is 49%. (Kennisinstituut voor Mobiliteitsbeleid, 2019). Amsterdam and Utrecht have rich local cycling cultures. In these cities, ambitions, policy plans and priorities related to cycling are not necessarily aimed at increasing cycling rates more, but at improving the quality of cycling and tackling cycling related urban challenges. In Amsterdam, the municipality wants to create more space through cycling infrastructure and increasing parking capacity for bikes. Utrecht wants to maintain its position as a world class cycling city by improving accessibility and existing infrastructure. In Eindhoven, historically more a car-oriented city, emphasis of cycling policy is on stimulating cycling and improving accessibility and connection with the region. Zwolle has the highest cycling rates of the Netherlands (and world). The starting point of cycling policy plans are improving speed and comfort of the cycling infrastructure.

3.2. Data collection and analysis

For this study, a qualitative case study approach was carried out, following conventions in interpretative and qualitative research (Yin, 2003) and participatory action research (Brown and Tandon, 1983). The

⁴ The co-creation process of LLs is the result of a successful grant application, driven by the different universities participating in this project. Hence, the authors of this paper also initiated the project and encouraged the authorities to engage in and start LLs.

whole process of initiating, designing, establishing and implementing a LL was studied. Closely monitoring the sequence of events was possible as the authors of this paper were involved in the organization of LLs. This engagement consisted of organizing four public kick-off events, initiating and coordinating local meetings with stakeholders (i.e. cities, regional governments, innovators), organizing project meetings in which research insights were shared policy-decisions were informed. Researchers had a two-fold role as participants in the LL and observers of the process. This double role will be reflected upon in the discussion section.

Empirical data was collected through interviews and participant observation during October 2016 until the end of 2020. The interviews were conducted in two rounds: February – March 2018 and May – August 2019. In total, 26 semi-structured stakeholder interviews were conducted, audio-recorded and transcribed. In the first round of interviews, questions were structured along key experimentation processes (i.e. visions, actors & resources, learning, context), but expressed verbally in a way that prevented the use of scholarly jargon. This provided general insight in how the LLs were designed and implemented. The second round of interviews—when the LLs were established—focused on progress, challenges, dilemma's and reflections about the LL process. LL stakeholders in four cities were interviewed representing municipalities ($n = 10$), provinces ($n = 5$), universities ($n = 7$), transport authority ($n = 2$), intermediary ($n = 1$) and the private sector ($n = 1$). See [appendix C](#) and [D](#) for the overview of interviewees and the interview protocol respectively. Interviews per cases are referred to by a1-a6 (LL1), b1-b6 (LL2) c1-c7 (LL3), and e1-e6 (LL4).

The interviews were analyzed and structured with Nvivo. A hybrid approach of inductive and deductive coding was used ([Fereday and Muir-Cochrane, 2006](#)). With inductive coding, recurring themes in the data that are not directly linked to the conceptual framework are labeled. In the deductive coding approach we identified the three experimentation processes and related challenges and dilemmas (see [table 1](#)), which were used as labels. Combining both approaches allowed for a focused analysis along the framework concepts while at the same time having an open attitude towards new, additional challenges and dilemmas outside the scope of our tentative framework.

4. Results

In this section, challenges and dilemmas, derived from the analysis of four cases, are outlined. The 16 challenges and dilemmas identified in [Section 2](#) are referred to in italics. For each of the three SNM processes we discuss key insights in terms of known challenges and dilemmas from the literature that stand out in our analysis of the cases, challenges and dilemmas that were not found in our analysis and new challenges and dilemmas, not covered by SNM literature.

4.1. Visions and expectations

A challenge that stood out was the *creation of visions and expectations* about specific LLs. The LLs evolved against the background of an overarching transdisciplinary research project. A broad and robust vision was shared among all stakeholders participating in this project. This vision was that cycling positively contributes to cities and that cycling innovation should be stimulated and researched.⁵ LLs were proposed as a method to experiment with cycling innovations in practice. The establishment of LLs was received with enthusiasm and created high

⁵ Since the Netherlands already has very high cycling rates, though they are uneven across different areas, the reasons why different urban and regional authorities take interest in cycling innovation are diverse and relate to high intensity of cycling in some areas (which e.g. generates parking capacity issues), yet to be achieved potential of some cycling routes and some inflexibility in multimodal journeys (combining cycling with other modes of transport, primarily train, in commuting between cities).

promises: a variety of actors were willing to join at the beginning of the project.⁶ Even after three years of collaboration most stakeholders perceive LLs as a fruitful approach because it helps to address local challenges, create knowledge and build relationships with cycling researchers (c6, b4, d5). Expectations were high enough to attract stakeholders, but were not unrealistically high to lead to disappointments. This reflects a *flexible attitude towards the vision* among stakeholders. However, *ensuring robust expectations* about local LLs was challenging in the beginning. Transforming an overarching vision, a variety of ideas and innovations, and diverse group of actors into four local LLs appeared challenging.

One reason for that relates to the ambiguous concept of 'cycling innovation', which was interpreted in various ways. Different expectations existed about what should be tested in the LL (c4, c5, d1, d2). Stakeholders mostly envisioned testing a physical innovation. For example, in the LL in Eindhoven, a city representative expected a high-tech driven innovation: "*I think I was fixated on technological innovation because they are very tangible. There were cycling innovations such as BikeScout – a smart lighting system that warns cars for approaching cyclists at crossings – or apps. I expected these types of innovation would play a more important role*" (c4). In contrast, some interviewees envisioned a social innovation such as a new way of governing cycling infrastructure projects (c6).

Selecting experiments for all LLs – and thereby *turning a broad vision into concrete experiments* with cycling innovation – was challenging. Local urban challenges and contestation played an important role. LLs are challenge-led and thus the selection of an experiment in Amsterdam and Utrecht was directed by the need to address local challenges. In Amsterdam, optimal use of bike parking facilities was a key challenge for the improvement of the regional cycling system and accessibility. This led to an experiment aimed at testing a potential solution to this challenge. In Utrecht, accessibility, bike parking and abundance of bikes were identified as key challenges, resulting in an experiment to test the potential of free-floating bike sharing (FFBS). In Eindhoven and Zwolle, linking the experiment to local urban challenges was more challenging. In these cases, involved actors (municipalities, provinces and researchers) had difficulties in reaching consensus regarding which specific questions and urban challenges to address, struggling to come to decisions what experiments to select and implement (c7, d6). A collective search process resulted in linking research capacity to existing cycling related projects, rather than co-creating new LL experiments.

Experiment selection was influenced by local contestation. In Amsterdam, initially FFBS was considered for experimentation. But FFBS had become a contested and politically sensitive topic because of disruptive launching strategies and the negative impact of free-floating bikes on public space.⁷ Therefore, the municipality did not want a FFBS LL experiment in public space. Also, it was not willing to choose one company in a LL over others interested (c4). Eventually, a politically less sensitive bike parking innovation was selected situated in a train station). This political sensitivity around FFBS also affected experiment selection in Utrecht, but in a different way. The fact that FFBS had become controversial in Amsterdam (FFBS was banned), made it an interesting opportunity to explore this cycling innovation in Utrecht.

⁶ To get a grasp of types of cycling innovations, four local kick-off pitch events (one in each city) were organized with entrepreneurs and innovators pitching 'cycling innovations' to cities. The events attracted approximately 50 cycling innovations (varying from smart locks, to peer-to-peer bike sharing systems, to smart parking infrastructure) attuned to local urban challenges. See <https://www.smartcyclingfutures.nl/events/> for brief reports of these events.

⁷ In October 2018, three months after their entry in the city, free-floating bike sharing firms were banned by the municipality of Amsterdam. Multiple firms introduced large numbers of bikes without formal consent onto the city streets leading to impact on public space and conflict with parking legislation (see [van Waes et al., \(2018, 2020\)](#) for an elaborate case studies).

Especially because firms were looking to relocate to another city after the ban in Amsterdam (b1, b4). In Utrecht, this political sensitivity was used to engage with FFBS firms and explore conditions under which FFBS can operate in line with city needs. Through a tender procedure one firm was selected.

A challenge not yet discussed in SNM literature was that – besides different interpretations of a cycling innovation experiment – also ambiguity existed among stakeholders in relation to the general concept of ‘LLs’ (What it can do? What it is about? Who will do what?) in the first part of the project (c, d1, d2). The concept was not entirely clear and was open to different interpretations. Two defining dimensions were identified in the project⁸: 1) the creation of an “experimental space”— a physical location to trial socio-technical innovations in practice 2) LLs as a method or new way of working and organizing an innovation process and collaboration between universities and urban and regional authorities.

This led to a challenge that roles and responsibilities were not clearly articulated. In all LLs unclear role expectations were recognized as a key challenge (a, b, c, d). In Amsterdam, Eindhoven and Zwolle, it remained unclear for a long period who would do what. Actors eventually took up roles depending on their own interest and expertise. Some stakeholders expected others to take up a specific role: e.g. researchers expected practitioners to lead in selecting an urban challenge, facilitate and/or take the lead in setting up the LLs; practitioners on the other hand assumed researchers to have a proactive role given they were in the lead of the project proposal, provide applicable knowledge and clear-cut solutions to their problems and manage the LL process. In the end, researchers took up multiple roles: initiator of LL meetings, building a network, sharing knowledge, critical observer and active LL stakeholder. In Amsterdam this led to frustration among practitioners as they felt they were being observed rather than provided with solutions to their problem: *“I sometimes felt a bit observed when I was arguing with the city or railway company. I was doing that on a table where also a couple of academics were thinking, oh, that, wow, interesting. It was almost like a camera observing how we were failing in our communication and everything. It felt a bit peculiar sometimes.”* (a3).

4.2. Social network building, actors and resources

The most prominent challenge that stood out from the cases – and also identified from the literature – was *creating broad networks*. As described in the previous section, attracting a broad variety of interested actors was not a problem given the high promises of the project. Especially in the beginning, in each region broad networks of potentially relevant stakeholders were formed. A variety of stakeholders joined LL meetings, exploring whether they might want, or could play, a role in the LL. In this period, LLs meetings were held, without formal structures (no formal decision-making procedure or rules of the game). The LL was in this phase a platform where stakeholders could meet and discuss progress (e.g. roles, what to experiment with, which stakeholders to attract, etc.). After roughly two years, four solid and harmonious local networks were formed (see [Box 1](#) for a description of different actors). *Navigating network tensions* within LLs was not an issue.

Although LL networks were formed, the early involvement of users – assumed important for a broad network for experimentation – on a local level appeared challenging. The relevance of involving users in an early stage did not come forward during the development stage, and consequently, direct user involvement remained very limited. Attempts to involve users were more indirect and on a project level, through cyclists representative groups such as Cyclists Union (Fietsersbond in Dutch) and Cycling Community (Fietscommunity in Dutch). The latter

⁸ This dual definition also translates into learning goals and expectations of stakeholders i.e. they aim to learn about the cycling innovation in practice and about the LL as a method.

organization engaged with the research project in knowledge sharing (e.g. organizing workshops). Limited user involvement was generally not seen as problematic in the early phase of setting up LLs by most actors. Some stakeholders see users indirectly represented through city actors (e6).

Another key challenge concerned *enabling deep networks* and mobilizing political and financial resources. For the LLs, this meant finding the right representatives within a municipal or regional authority, with decision-making power and/or access to financial resources for the establishment of LLs (b5). Financial resources for doing LLs were initially lacking in all regions. Part of the misunderstanding about role expectations described earlier, was misunderstanding about financial resources needed to set up and manage LLs. In the project proposal, it was not clarified who should provide these resources and no budget was allocated for implementing LLs (c5). This led to a temporary deadlock in establishing LLs. Practitioners expected researchers to take up a proactive role in setting up LLs (c5, d3). However, besides research capacity, no financial resources were available for implementing LLs from the university-side.

Too much *dependency on resources* and external protection did not come forward as a key dilemma. Financial and political support played an important role in LLs in Amsterdam and Utrecht. Policy networks proved important for generating wider support. Both cases also show a local sense of urgency in solving urban mobility related challenges and the contribution of cycling innovations. In Utrecht this translated into high level support for bike sharing and urban experimentation, formalized in a policy letter (b1). This political support translated into financial support. Financial resources provided a solid breeding ground for the establishment of LL2. A budget (part of a national program to improve accessibility) spurred development as it was used to appoint a project manager (b1). In Amsterdam financial resources were mobilized that should address parking capacity, which is identified as a regional issue in an administrative agreement⁹ (a8). In contrast, the municipality of Eindhoven dealt with budget cuts (new pilots were critically assessed, including LLs) and limited human capacity affecting the local LL. The city spent more hours and budget on the LL than was budgeted beforehand (c4). Across all LLs *generating public support* for the experiments was not a clear challenge.

Organizing leadership was a challenge in all LLs. Limited leadership or coordination was perceived as a hampering factor in the set-up phase, as reflected by a practitioner: *“It’s quite difficult to navigate in between the practical side and the academic side. Somebody taking the lead would be really helpful in future living labs. Both sides could really help each other much more. I think it has a lot of potential if you put these together. The academic world having the theoretical knowledge and us being practical and having less of this knowledge.”* (a3). This insight improved understanding about the need for a dedicated LL project manager as this was recognized as a necessary strategy to continue LL development.

Appointing a LL manager was facilitated in two cases by the mobilization of financial resources (provided by governments). This led to immediate progress in Amsterdam and Utrecht as a dedicated manager took the co-creation phase into a more traditional project form. In Amsterdam, this was a regional transport authority, not hindered by political tensions around FFBS experimentation unlike the municipality. In Utrecht, the municipality appointed a dedicated project manager. Stakeholders in these LLs experienced this as a positive and necessary contribution that provided clarity, direction and action to the LLs (a5, a6, a7, b6, b7).

Engaging with ‘regime’ insiders and/or outsiders only occurred in LLs in Amsterdam and Utrecht in which the LL innovation could challenge vested interests. In Utrecht, a relative newcomer was selected to operate

⁹ The agreement – ‘Bestuursakkoord Fietsparkeren’ – was signed by actors including Municipality, Regional Transport Authority, and railway and rail infrastructure companies.

a FFBS in the city, even though the national railway company operates the largest (station-based) bike sharing system in the Netherlands. The LL in Amsterdam can be viewed as a more radical socio-technical experiment in which also incumbent actors (such as the national railway company and the rail infrastructure owner) are involved. Involving them was both challenging and necessary as they own and manage parking space needed for the placement of the bikes. But their involvement also influenced the experiment (a7). For example, it was not possible to use bikes of the existing (station-based) bike sharing system (operated by the railway company) for this experiment because it was worried that negative results of the experiment would affect their reputation. Nevertheless, such interference did not pose a clear dilemma for experimentation.

4.3. Learning

All learning dilemma and challenges identified from literature occurred in the LLs. Closely related were the dilemma to *enable broad learning* and the challenge of *aligning learning goals across organizations*. For some the goal of LLs was about (first order) learning about practicalities of the innovation. Municipalities, practitioners, innovators and applied researchers were interested in the practical implications of LLs (e.g. what is the impact of bike sharing on modal shift? What are user motivations?). Researchers and some municipalities also aimed at *reflexive learning* i.e. learning about the broader problem, the LL process as an approach to organize urban innovations and learn from collaboration between practitioners and universities. These actors were mostly interested in more fundamental questions (e.g. what can we learn from the LL as a method of reflexive governance and for urban innovation?). The municipality of Utrecht endorsed both goals: *“It would be nice that the innovation will become a success. And it would even be nicer that this urban living lab process has contributed to that. Although personally I would like that bike sharing system will be successful. However, professionally, I’d rather see that the process will teach us many new things such as what went wrong and how we can embed this process in future policy within our organization.”* (b3).

A tension between *learning goals* was that for researchers it did not really matter whether LLs were successful or failed, as they were primarily interested in drawing lessons. For practitioners, there was more at stake as they can be held accountable. *“For academics, failure also provides insight. Municipalities don’t have that luxury situation.”* (c6). However, for some government actors, the LL approach enabled them to allow for failure (b4). Tension between different interests created disruptions in the LL process.

An important challenge was to *facilitate reflexive learning* within all LLs, in particular in relation to each other’s backgrounds. LL participants are grounded in different contexts representing different professional ‘worlds’, with different languages and professional jargon (English vs Dutch; abstract vs practical) different outputs (policy & concrete plans vs scientific articles) and timeframes (long vs short term). Misunderstanding of these different working environments was emphasized by one practitioner: *“One of my assumptions is that scientists have less affinity with the erratic and unruly reality we deal with in practice. We are hands-on and not just sitting behind a desk. We are the ones sitting at the table with our inhabitants, and have to prepare plans and decisions with our administrators. We have to deal with angry citizens. So these are different worlds.”* (d2). Learning about different backgrounds and disciplines can be challenging, as shown in LLs in Eindhoven and Zwolle. Practitioners tended to struggle with learning from academics as they were working on more fundamental questions, less relevant to daily practices of local governments. This limited understanding was emphasized by a practitioner: *“I don’t have an academic background and like me, most colleagues at our department have a more practical background so we don’t know how the university works. When you distinguish fundamental and applied research, we don’t know. So expectations don’t match. I just think: I have some societal questions that I would like to get investigated. But researchers have their PhD*

projects, which have their own requirements. It took us two years to understand this” (c1). Also different stakeholders use different professional jargon and may take for granted background knowledge that is not shared by others.

According to most stakeholders, more *learning across LLs* took place, in particular about experimentation processes (a3, c2, d5). All stakeholders were struggling in the startup phase. Sharing insights about what worked and what did not contributed to local LL development. To facilitate this learning process, a number of workshops were organized, prior to which interviews were held to obtain lessons about practicalities and experiences.

5. Discussion

5.1. Contrasting challenges and dilemmas across cases

Table 2 shows that most of the known challenges and dilemmas from literature also occurred across the four LLs.¹⁰ However, differences between LLs can be observed, which suggest the importance of place-based aspects in strategic urban experimentation (Hansen and Coenen, 2015; van den Heiligenberg et al., 2017). Here we discuss similarities and differences across LLs, including potential reasons for these differences, grounded in an understanding of different place-based conditions.

First, we observe that creating a robust vision and expectations about the socio-technical innovation was challenging in all LLs. In contrast, none of the LLs faced the dilemma of flexible vs persistent attitudes towards LLs. No notable differences in challenges and dilemmas related to visions and expectations between LLs were identified.

Second, creating broad networks and enabling deep networks was challenging but was not a major issue. Also, LLs did not suffer under too much or too little protection (dependency vs autonomy). However, creating broad networks, enabling deep networks and organizing leadership and coordination was less challenging in Amsterdam and Utrecht - cities that have a long cycling history – than in Eindhoven and Zwolle. A hypothesis is that these mature cycling environments are characterized by existing social networks around cycling, which are historically better developed and better equipped to support strategic urban experimentation with cycling innovation. Both cities also have more pressing cycling related issues such as parking problems and the abundance of bikes, hence there is a sense of urgency to experiment with cycling innovations. This is translated in supportive political agendas and financial means for experimentations. Related to these strong local networks, results show that aligning learning goals between organizations in a LL was less challenging in cycling cities. A possible explanation is that pressing cycling related issues in these cities created a shared understanding and interest in tackling these problems which translates into a relatively easy alignment of learning goals.

Third, strategic experimentation is entangled with local political agendas and resources. Supportive regional or urban visions can help stimulate experimentation (van den Heiligenberg et al., 2017). Part of what makes experimentation become *strategic* is when it gets linked to political agendas.¹¹ For example, agendas around cycling stimulation, improving accessibility and parking capacity at train stations have positively influenced LLs in Amsterdam and Utrecht. However, lack of such linkages negatively affects the capacity for strategic urban experimentation. For instance, in Eindhoven cycling is still marginal in terms of political priority, which means that local agendas can only to a limited extent be mobilized.

¹⁰ The identified challenges are in line with Hossain et al (2019) who recognizes similar living lab challenges such as governance, efficiency of learning, temporality and scalability.

¹¹ In practice, getting commitment from partner organizations can be a timely but crucial, process as often agreement has to come from different levels within the organization.

Table 2
Challenges and dilemmas from SNM in LLs (● =strong, ○ =occurred but no major issue, - =not occurred).

		LL1	LL2	LL3	LL4
Vision and expectations	Challenge	1. Create a vision and/or concrete expectations ●	2. Ensure robust visions and expectations ●	3. Too high vs too low expectations ○	4. Generating public support ○
	Dilemma	1. Broad vs narrow experiment (selection) ●	2. Flexible vs persistent attitude towards vision -	3. Too high vs too low expectations ○	4. Generating public support ○
Network, actors and resources	Challenge	1. Creating broad networks ○	2. Enabling deep networks ○	3. Navigating network tensions -	4. Generating public support ○
	Dilemma	1. Engaging with 'regime' insiders vs outsiders ○	2. Dependency vs autonomy -	3. Navigating network tensions -	4. Generating public support ○
Learning	Challenge	1. Facilitating reflexive learning ●	2. Aligning learning goals across organizations ○	3. Learning across experiments ●	4. Generating public support ○
	Dilemma	1. Broad vs narrow experiment (selection) ●	2. Flexible vs persistent attitude towards vision -	3. Too high vs too low expectations ○	4. Generating public support ○

Fourth, a supportive environment for strategic urban experimentation also enabled building unconventional coalitions in which both innovators and incumbent actors collaborate. At the same time, a strong local cycling culture in these cities meant that experiments and innovations challenge the prevalent norms of private bike ownership could lead to limited support, but it did not. Although Zwolle today is also an ambitious cycling city, its ambition has only relatively recently become more explicit and politically enacted. There are no pressing cycling related issues as observed in Amsterdam or Utrecht. Hence, there are other policy priorities, such as speed and comfort of cyclists using the cycling infrastructure. At the other end of the spectrum there is Eindhoven, a city historically more car-oriented, at least relative to the other three cities. Here, cycling is less prominent as a political priority, which leads to limited resources to support cycling innovation experiments.

Finally, similarities in challenges and dilemmas across different LLs may be partly influenced as they are connected through the overarching research project consisting of a network of academic researchers. This connection has influenced strategies to respond to challenges. For example, it allowed to recognize that a successful intervention in one living lab (appointing a project manager) could also be applied in other living labs.

5.2. General reflections about challenges and dilemmas

In addition to these similarities and differences across the cases, and the relevance of taking a place-based approach to strategic urban experimentation, we discuss two broader reflections about challenges

Box 1

Cases of strategic urban experimentation: cycling innovation living labs.

Living Lab 1: Exchange bikes in Amsterdam

This LL is situated at the train station of the Zuid-as business district, close to the city. 200 selected commuters from and to this train station received a free bike – out of a pool of 120 bikes. One group of people who travel to the train station by train can take a bike upon arrival at the train station and use it to travel to their final destination. The other group of people, who live close to the train station, use this bike from their homes to travel to the train station. In theory, this idea could drastically reduce (50%) parked bikes at train stations. Bike parking capacity at train stations is a pressing challenge in many Dutch cities, and mainly at train stations. Throughout the whole country, bike parking capacity at train stations is being expanded. However, often, these parking facilities will reach full capacity soon after they are delivered. Moreover, such publicly funded parking infrastructure is costly. Stakeholders involved in the LL are a bicycle producer providing the bikes, the national railway company (which also operates a nation-wide station-based bike sharing system), the rail infrastructure company (owner of the parking facility), the municipality of Amsterdam, two research institutes (a local university and university of applied sciences) and the regional transport authority who manages the project.

Living Lab 2: Free-floating bike sharing in Utrecht

This LL is about testing the potential of free-floating bike sharing for a period of two years. The municipality of Utrecht selected one bike sharing provider that has the sole right to provide this service to users in the city. The city's goal is to learn about the potential and implications of free-floating bike sharing, as a solution to address local urban challenges such as accessibility and bike parking. The city is also interested in learning from the LL as a method. Researchers of the local university and a university of applied sciences are involved in the LL to study parking conditions and to conduct a user survey. The LL is managed by the municipality.

Living Lab 3: Researching bicycle highways in Eindhoven

This LL involves a cooperation between the regional government (province of North Brabant), the municipality of Eindhoven and other principal cities of the province. The LL involves empirical research into bicycle highways as a new form of bicycle infrastructure and what design and governance principles are necessary both to develop a comprehensive network and to integrate this into the existing bicycle infrastructure. Unlike the cities of the other LLs, here the focus is more on offering attractive alternatives to driving rather than accommodating cycling growth. Another focus is on best practices for integrating feeder routes with bicycle highways. Between the major cities of the province of Brabant there is a network of bicycle highways.

Living Lab 4: Monitoring cycling infrastructure in Zwolle

This LL links to an existing infrastructural project that aims to upgrade a cycling road between a city of Zwolle and the village of Dalfsen. In this LL, the regional government is involved as well as both municipalities that are linked through the cycling road. The focus of the living lab is particularly related to learning about processes of collaboration between different governmental stakeholders.

and dilemmas as observed in the current literature and the results from our analysis.

5.2.1. Strategic urban experimentation processes

We observed a difference concerning articulating (and managing) robust expectations about processes of strategic urban experimentation. Whereas extant niche experimentation literature points at the importance of articulation of visions and robust expectations about the socio-technical innovation, the cases show that aligning visions and expectations about the concept of LL experimentation itself (e.g. its methods, roles, responsibilities, procedures) is critical, too.

Our findings suggest that different interpretations of what LLs should be and enable existed. Shared visions and expectations about the concept of LLs were created in the process of setting them up. It took two years for LLs to become robust projects in which expectations, goals, roles and the approach became established among the stakeholders. This resonates with Verbong et al., (2008) who recognizes that experiments often start as platforms for interaction and establishing them is a process of muddling through, understanding each other and learning by doing rather than a clearly defined process with strict agreements. Research on transdisciplinarity also highlights that lack of a clear and shared focus about new forms of governance (in our case LL experimentation) is a key challenge (Scholl et al., 2018).

A notable observation is that LLs in Amsterdam and Utrecht evolved from a typical LL approach (i.e. co-creation, broad vision, open to a variety of perspectives, ideas and initiatives, high level of uncertainty) to a more traditionally structured project-based approach (i.e. clear defined goals, clear roles and responsibilities, certainty) which enabled a

more effective collaboration among LL actors. The LL became embedded in existing organizational structures, and the more established the LL became, the less open and emergent the LLs became. This development coincided with the appointment of LL project managers. Indeed, earlier research suggested that linkages with formal government structures and clear leadership are crucial aspects for LL development (Scholl et al., 2018; Voytenko et al., 2016).¹² This insight – transforming LLs into more a clear-cut projects facilitates embedding in organizational structures – also contributes to literature that recognizes the challenge of institutionalizing experimentation as a mode of governance in organizational structures (Sengers et al., 2019; Voytenko et al., 2016). A question remains whether this creates a new dilemma of maintaining the innovative and transformative potential of a LL, while adapting to and embedding it into existing practices and institutions.

5.2.2. Stimulating transdisciplinary reflexivity

We want to highlight transdisciplinarity as a critical challenge that future work on strategic urban experiment should engage with. From SNM we know that reflexive learning is important for experimentation. A key observation and dilemma concerns reflexivity in transdisciplinary research collaborations between universities and urban practitioners. Reflexivity means that actors turn a critical gaze upon themselves (Finlay and Gough, 2008). For example, our research demonstrates that potentially conflicting learning goals within such a research collaboration can impede fruitful learning and experimentation, and should therefore be reflected upon. In particular, we discuss here our own position and role in the living labs.

Reflexivity about the role of researchers is a key insight from literature on transdisciplinary research (Jahn et al., 2012; Lang et al., 2012). Transdisciplinary research requires scholars to reflect on their role as researchers, their research focus and methodology and their relation to academia and society (Knaggård et al., 2018). When participating in transdisciplinary research, researchers are not just knowledge makers, but facilitators of change, and hence consciously or not, they are changing their own roles, identities and values in the process (Pereira et al., 2019). Likewise, research suggests that transitions' researchers can have different roles: reflective scientist, process facilitator, knowledge broker, change agent, and self-reflexive actor which refers to being reflexive about one's positionality and normativity, and to seeing oneself as part of the dynamics that one seeks to change (Wittmayer and Schöpke, 2014).

Researchers committed to not only describing transformation processes but also initiating them face the engagement vs distance dilemma

¹² For most municipalities, LLs were also governance experiments, which has the ability to bring about change of formal governance structures (Bos & Brown, 2012).

¹³ This dilemma relates to a broader debate about the relation between science and society. A key question is how researchers can respond to societal challenges. According to Kueffer et al. (2012) researchers face three challenges: the complexity challenge (i.e. how to combine various disciplines, also from outside academia), the impartiality challenge (i.e. how to ensure research serves common interests when knowledge is used in decision-making) and the salience challenge (how to produce useful knowledge for decision makers or practitioners).

¹² For most municipalities, LLs were also governance experiments, which has the ability to bring about change of formal governance structures (Bos & Brown, 2012).

¹³ This dilemma relates to a broader debate about the relation between science and society. A key question is how researchers can respond to societal challenges. According to Kueffer et al. (2012) researchers face three challenges: the complexity challenge (i.e. how to combine various disciplines, also from outside academia), the impartiality challenge (i.e. how to ensure research serves common interests when knowledge is used in decision-making) and the salience challenge (how to produce useful knowledge for decision makers or practitioners).

¹⁴ On a more mundane level that can translate into a question such as whether one should focus on listening during a meeting or actively interact and shape the conversation. A partial solution to that dilemma would be to split roles with some researchers taking notes and observing everyone while others participating more actively.

(Köhler et al., 2019).¹³ The dilemma is how to be an engaged participant while also be able to take some distance to critically observe. Positionality – the stance of the researcher in relation to the object of study – is therefore key to reflect upon (Coghlan and Brydon-Miller, 2014). The position adopted by the researcher affects every phase of the research process: from problem definition to research design to how other are invited to participate. To work with the engaged researchers dilemma, Wickson et al., (2006) suggest researchers should nurture reflexive research habits.

Being engaged in strategic urban experimentation, we suggest that our position as researchers has influenced the research process and the development of LLs, which in turn have influenced research outcomes. We took up and navigated between different roles (e.g. initiating the research project, setting up local LL experiments, facilitating learning across LLs, examining its progress and sharing insights). Being both observers and participants, we have continuously faced the engagement-distance dilemma. To what extent should we intervene in the course of events?¹⁴

6. Conclusion

In this paper, we asked the question: what are challenges and dilemmas in doing strategic urban experimentation? To this end, we systematically reviewed SNM literature to develop a tentative framework of challenges and dilemmas, enriched with recent insights from transdisciplinary research on living labs. This framework was tested through transdisciplinary case-study research in four cycling innovation LLs. We unpacked place-based dimensions and provide an additional set of explanatory arguments of why the cases unfolded as they did in terms of challenges and dilemmas. As such, this framework has proved useful as a sense-making and analytical device for exploring challenges and dilemmas in strategic experimentation. Future studies could use the framework for similar analysis in other domains or geographies. Future studies could also explore the usefulness of this framework beyond analytical purposes by using it to design the (governance of) strategic experimentation. Finally, the framework was designed to make sense of challenges and dilemmas at the level of local experiments. As such, future work could explore challenges and dilemmas at the level of 'global niches' (Geels and Raven, 2006), including challenges and dilemmas related to empowering niches (Smith and Raven, 2012).

A new challenge concerns articulating and managing expectations about processes of strategic urban experimentation itself. LLs started as open processes but along the way turned into more closed projects. Managing this process involves balancing between embedding LLs in existing structures while maintaining openness to new ideas. We also found that engaging in strategic urban experimentation brings new dilemmas for researchers being both observers and facilitators of strategic urban experimentation. Further research could focus on systematically investigating strategies to deal with the identified challenges and

¹⁴ On a more mundane level that can translate into a question such as whether one should focus on listening during a meeting or actively interact and shape the conversation. A partial solution to that dilemma would be to split roles with some researchers taking notes and observing everyone while others participating more actively.

dilemmas and the broader impact and upscaling dynamics of strategic urban experimentation. While this study has made use of recent insights from transdisciplinary research on living labs, there is considerable scope for a broader and more systematic discussion of how transdisciplinary approaches can enrich sustainability transitions research.

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Appendix

A. Literature review

A literature search was carried out to identify relevant articles that discuss Strategic Niche Management and experimentation processes. This search encompassed the following steps. In the first step key words were defined and used to search for matching articles with these words in the titles, abstract or key word section. The following query was used in Scopus: TITLE-ABS-KEY ('strategic AND niche AND management' AND (learn* OR network* OR expectations* OR vision*)) AND (LIMIT-TO (DOCTYPE, "ar")). This led to a first result of 132 articles (august 14th 2019). This set was further narrowed down by reading the abstracts. When the articles show a meaningful relationship with SNM literature and its processes, it was selected as a contribution to the literature review. This selection procedure resulted in 53 articles. This set of articles was coded in Nvivo with the aim of identifying challenges and dilemmas of experimentation. Hence, aspects were labeled as a challenge or dilemmas related to visions and expectations, actors and network building or learning (resulting in six different labels). Reading and coding the articles, the ones that did not show a meaningful relationship with the aim of our paper were excluded from the analysis. Eventually 29 articles were selected for the analysis. The three experimentation processes were labelled and categorized as a challenge or dilemma, based on the definition provided in footnote 2.

B. Operationalization table

	Challenges and dilemmas	Signifying terms / key words in data (examples what to look for)
Visions & expectations	1. Create a vision and/or concrete expectations	- Mentions of broad and/or concrete visions and expectations - Stakeholder goals of participating in LLs
	2. Ensure robust visions and expectations	- Varying visions and expectations of the project and LLs - Different understandings/interpretations of LL and socio-technical innovations
	3. Broad vs narrow vision and experiment (selection)	- LL definitions among stakeholders
	4. Flexible vs persistent attitude towards vision	- Changing responses to LL developments
	5. Too high vs too low expectations	- Varying expectations at different phases of LL development
Network	1. Creating broad networks	- Involvement of a variety of stakeholders and perspective (e.g. governments, companies/innovators, universities, users etc.)
	2. Enabling deep networks	- Involvement of stakeholders and ability to mobilize resources (e.g. political, financial)
	3. Navigating network tensions	- Conflicts within LLs
	4. Generating public acceptance and support	- Limited support about LLs how it is received among the broader public
	5. Organizing leadership and/or local coordination	- Role and presence of a local manager or coordinator of LLs
	6. Engaging with 'regime' insiders vs outsiders	- Involvement of incumbent actors (e.g. public transport companies) or outsiders (e.g. innovators/entrepreneurs)
Learning	1. Facilitating reflexive learning	- Reflexive learning processes taking places
	2. Aligning learning goals across organizations	- Mentions of learning goals of different stakeholders
	3. Learning across experiments	- Processes of learning between LLs
	4. Enabling broad learning	- Different learning aspects: technical (about the innovation) and social (about broader conceptions of the innovation and experimentation in general)

C. Overview of interviewees

LL	Round	Interviewee	Reference	Date
1	1	Municipality	a1	26-2-2018
		Municipality	a2	20-3-2018
		Regional Transport Authority	a3	21-2-2018
		University- Urban Planning Department	a4	27-2-2018
	2	Municipality - project manager bike parking	a5	19-7-2019
		Regional Transport Authority	a6	3-7-2019
		University - Urban Planning Department	a7	21-5-2019
		Consultant - temporary project manager	a8	27-5-2019
3	1	Municipality - cycling policy maker	e1	27-8-2018
		Province- policy maker	e2	27-8-2018

(continued on next page)

(continued)

LL	Round	Interviewee	Reference	Date
		University – Innovation Sciences Department & Urban Planning Department	e3	26–3–2018
	2	Municipality – cycling policy maker	e4	16–8–2019
		Province – policy maker	e5	16–8–2019
		University – Innovation Sciences Department	e6	12–8–2019
		University – Phd Candidate	e7	6–8–2019
2	1	Municipality – project leader cycling program	b1	1–3–2018
		Municipality – project manager living lab	b2	1–3–2018
		Province – policy maker	b3	2–3–2018
	2	Municipality – project manager living lab	b4	14–5–2019
		University – Innovation Studies Department	b5	4–6–2016
		Bike sharing firm – local project manager	b6	5–6–2019
4	1	Municipality A	d1	5–3–2018
		Municipality B	d2	5–3–2018
		Province – department of	d3	5–3–2018
	2	University of applied sciences – researcher	d4	19–8–2019
		Municipality B – project leader	d5	7–8–2019
		Province – department of	d6	7–8–2019

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