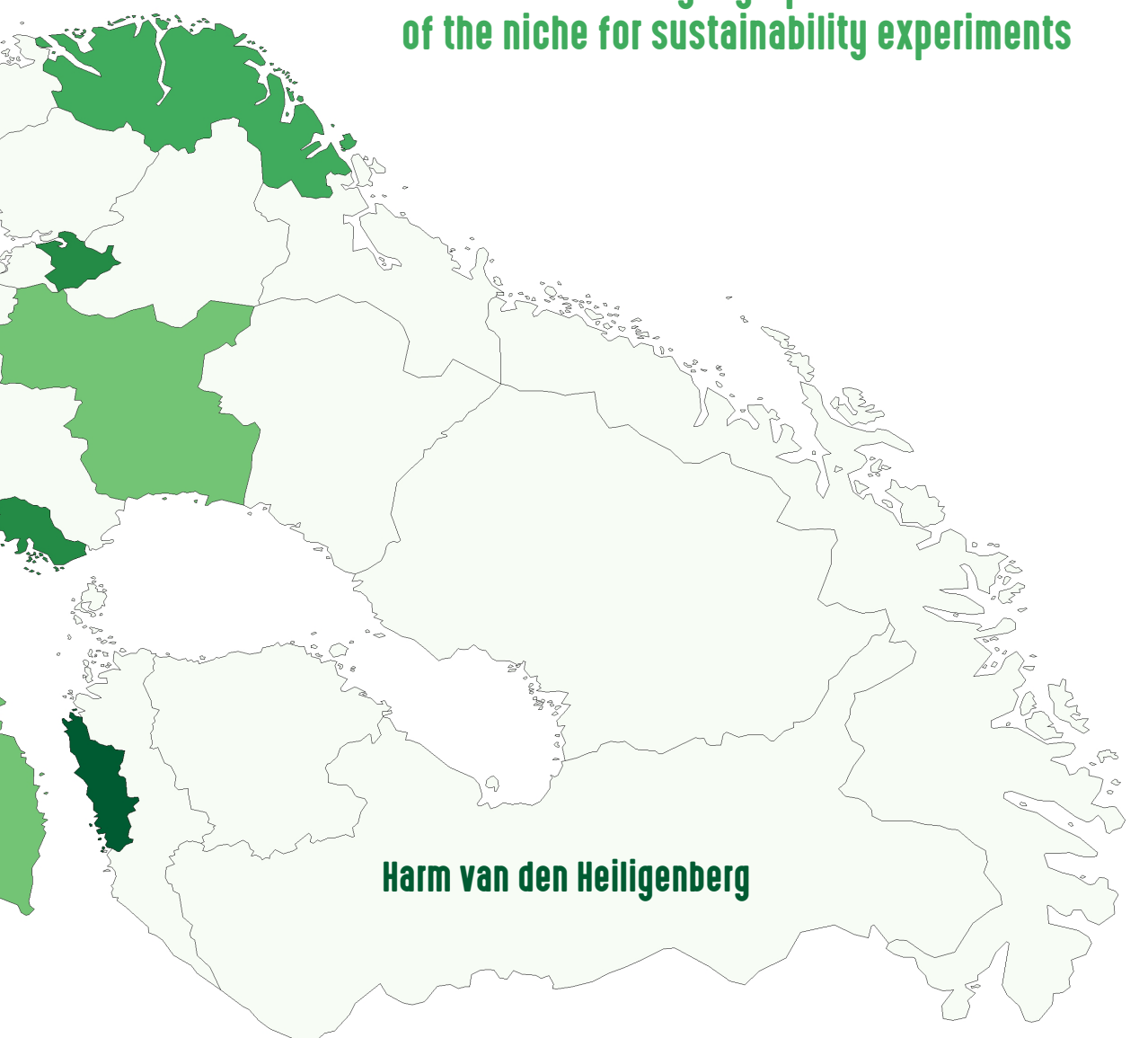
Habitats and harbours for sustainability experimentation in the regions of Europe

A contribution to the geographical articulation of the niche for sustainability experiments



Harm van den Heiligenberg

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Habitats and harbours for sustainability experimentation in the regions of Europe

A contribution to the geographical articulation of the niche for sustainability experiments

Habitats en harbours voor duurzaamheidsexperimenten in de regio's van Europa

Een bijdrage aan de ruimtelijke articulatie van de niche voor duurzaamheidsexperimenten

(met een samenvatting in het Nederlands)

Proefschrift

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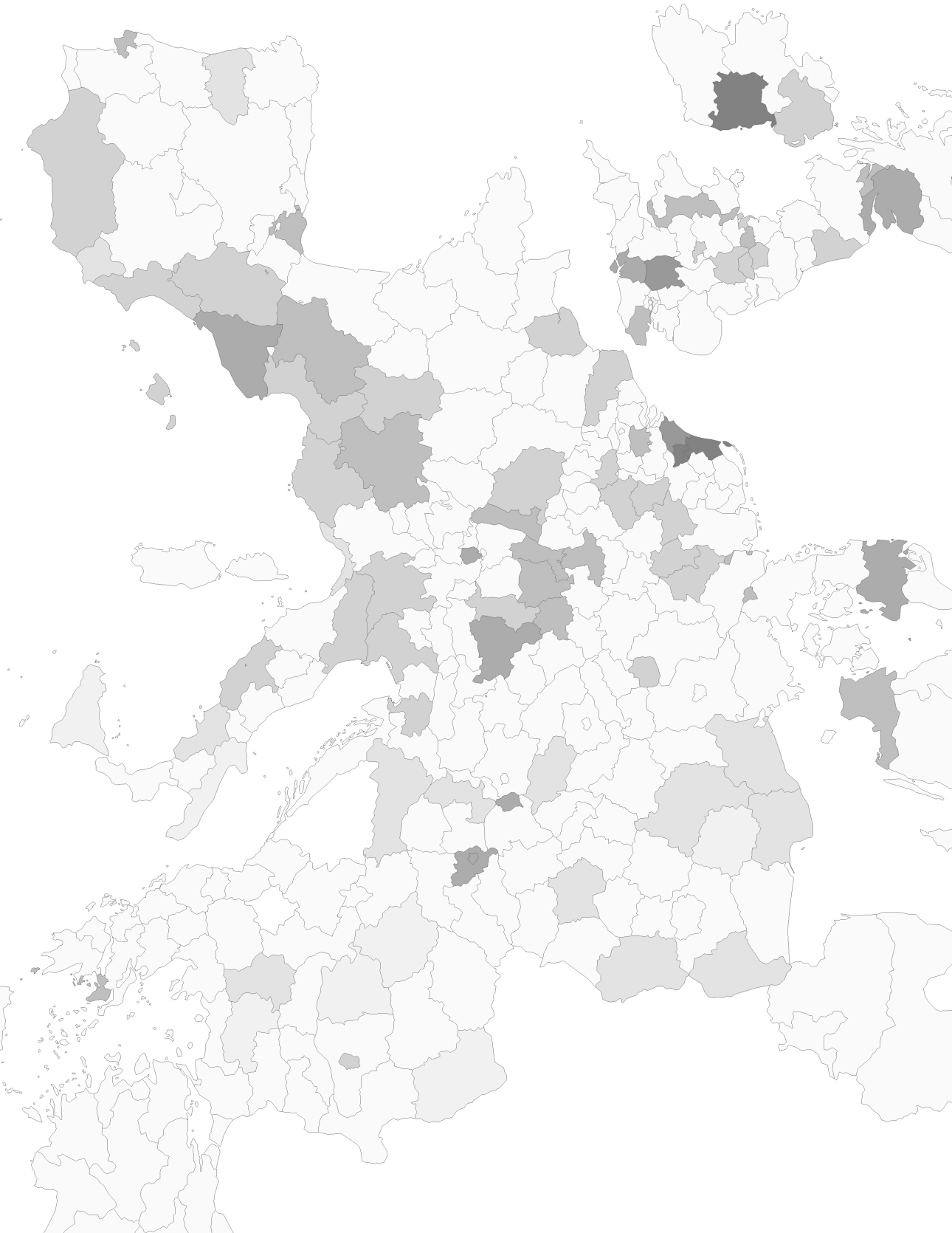
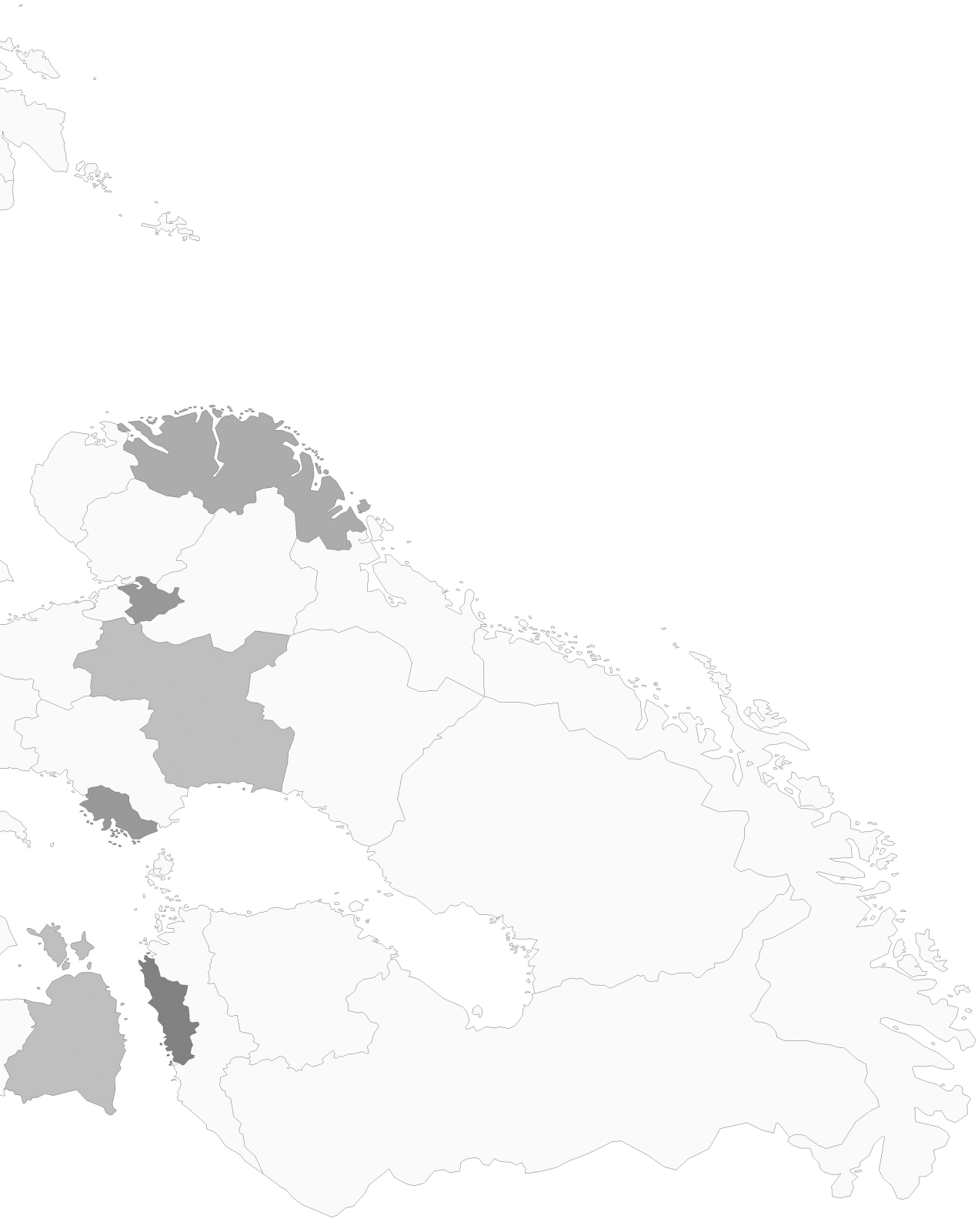


Prologue

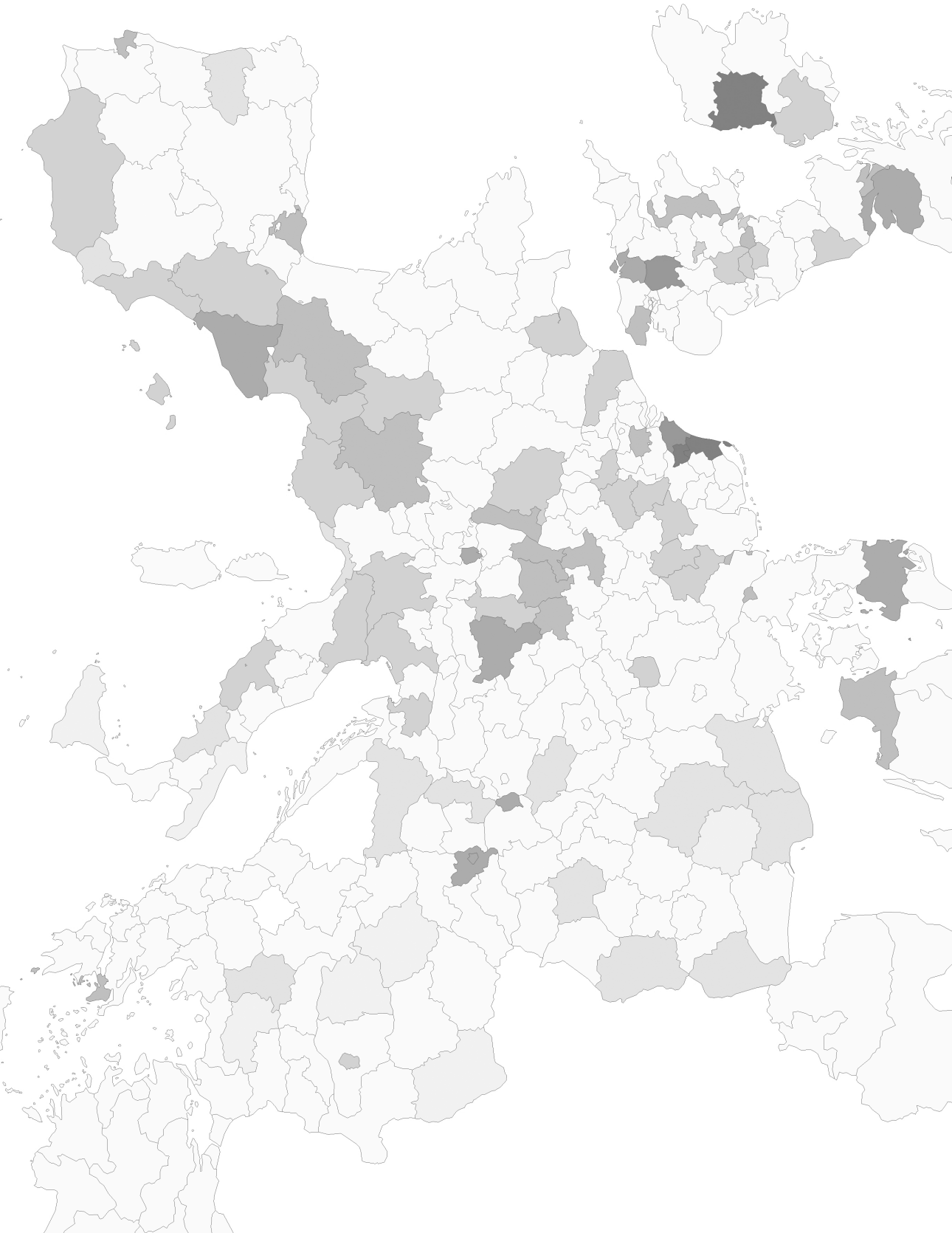


Voices of fear and hope

While traveling through Europe for my PhD research I arrive in Budapest, where I meet Era. I grab my questionnaire and my notepad, and start the interview.

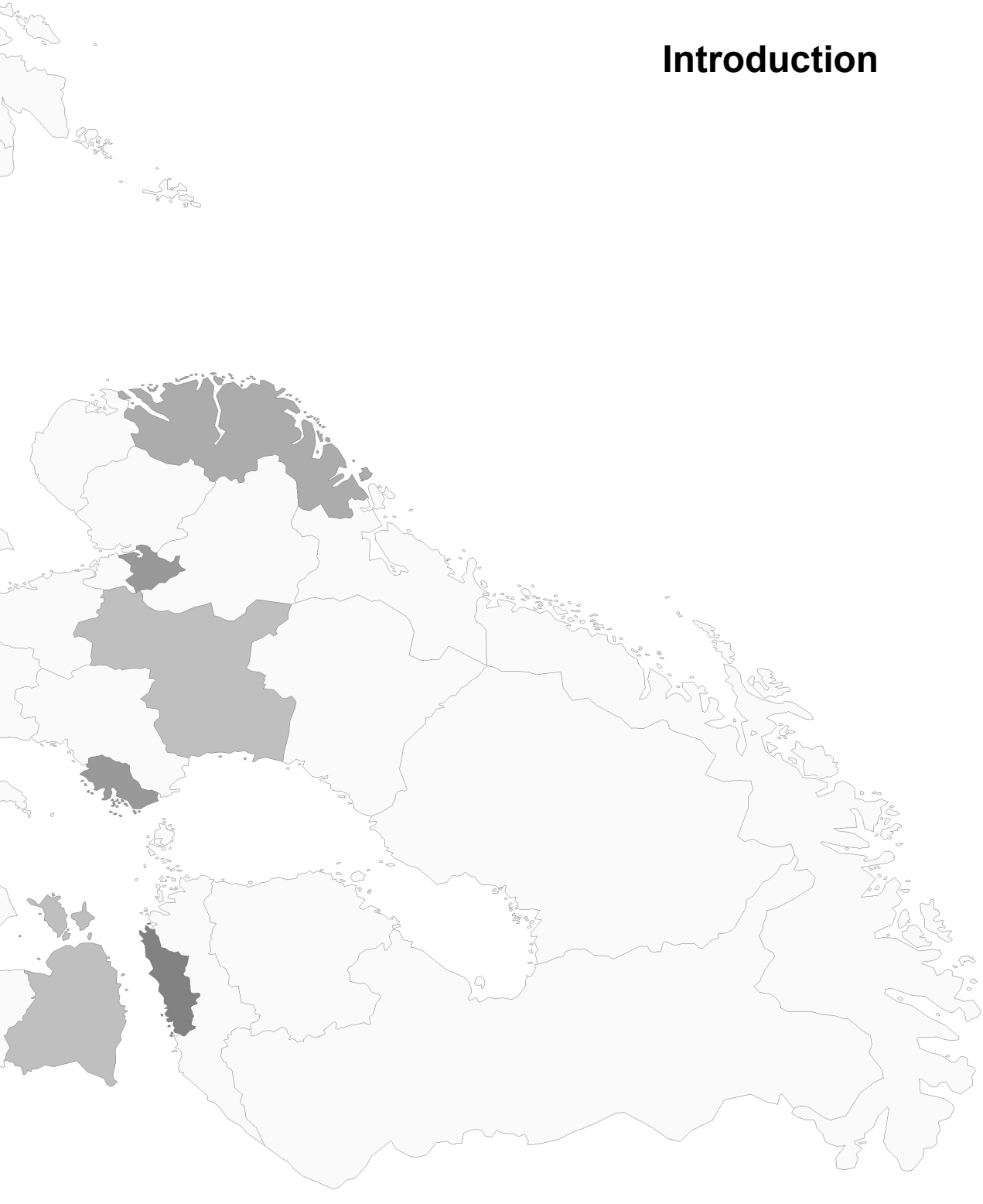
"Hello, my name is Era, welcome to my local food shop. Nine years ago, I started this initiative, together with a group of friends. We wanted to buy responsible food from local farmers and sell it in the city. We wanted to work purely on trust; with trust in the farmers and trust in each other. So: no contracts.
It was not an easy time in those years; we had a lot of competition from the supermarkets, and we had little help from others. For me it was important to earn a stable income and at the same time to avoid a burn-out.
However,… we know that things can be done differently! We have the commitment! We have the strong feeling: Yeeaahh, I'm part of something important! I want to support this movement, with its higher goals and values!"
And then, she looks at me in the eyes and whispers… *"we are part of a global community".*

This story tells in a nutshell what this whole research is about. We live in a time of fear and hope, of crises and scrambling up, of the global and the local, of top-down and grassroots. The story of Era shows how these polarities may get together. She works on an innovative alternative local grassroots initiative, in the context of an existing globally organised food provision system. The development and further diffusion of this initiative is not easy. She is worried about the continuity of her project, and about the stress this pioneering work entails. However, at the same time she is hopeful that her work contributes to a better world in future.
This story and many other stories have given me a strong motivation to do this research: I want to contribute to a better world, by gaining more insight in what is needed for these sustainability pioneers to accelerate system change.



Chapter 1

Introduction



1.1 The need for sustainability transitions

Almost every day, we are confronted with alarming reports on topics such as the possible collapse of a glacier in Antarctica, the changing growing season of plants and the decline of the bee population. These are alarming signals that come close to our daily lives and are signs of a much larger underlying sustainability problem. We are approaching the biophysical limits of the Earth system, as is the case with climate change, the biodiversity loss of plants and animals and the human disruption of the nitrogen cycle (Rockström et al., 2009). These problems have been known for several decades but have not been solved. In contrast, the absolute increase in global greenhouse gas emissions in the past decade was the highest on record (IPCC, 2022). The urgency of the global sustainability challenge requires a transition, i.e., a large-scale fundamental societal change that may take several decades to complete, for instance, a change in the systems for the provision of energy, food and mobility. To date, however, progress has been rather limited (Sachs et al., 2019) because existing systems exhibit high degrees of inertia (Markard et al., 2020). An important societal question is how to accelerate this transition. With this dissertation, I aim to contribute to answering this question.

According to various authors, a sustainability transition is already occurring; they state that we are currently in the middle of a larger long-term development, moving away from an industrial epoch to a new epoch, for instance, with more sustainable provisioning systems (Perez, 2009; Schot and Kanger, 2018; Swilling, 2020). Transition studies suggest that these fundamental societal changes may start small, for example, in practice-based sustainability experiments. At present, it is observed that large numbers of experiments are being carried out worldwide (OECD and World Bank, 2014). This experimentation is related to the approach of ‘radical incrementalism’. In this approach, the view is that a radical transition is needed, without assuming that a classical revolution is necessary. The transition can then be realised along an incremental path; the starting point is formed by carrying out practice-based experiments (Swilling, 2020).

1.2 Experiments are carried out

The large numbers of sustainability experiments carried out worldwide concern the testing of technological innovations (involving technological novelties), as well as social innovations (involving new ways of finding solutions for societal challenges and including behavioural change), and they are initiated by a variety of actors, such as citizen groups, alternative groups, firms and governments.

Citizen groups carry out grassroots experiments with various local sustainability solutions, e.g., community gardens, repair cafés, energy and care cooperatives, local circular production, sharing electric vehicles, and sharing data and software; see Geels (2019) for an overview. People's motivation to join these experiments is based upon different values from those of the mainstream, for example, by a bottom-up generation of alternative systems of provision (Seyfang and Smith, 2007). Their organisational form is diverse and consists of, for example, voluntary associations, co-ops and informal community groups. Some of these solutions may be framed as a critical response to the current economic system, with globalisation and the increase in the scale of production as important features. As early as the 1970s, Schumacher (1973), in his book "Small is beautiful", raised critical questions about these topics. He stated that in society, 'we have gone too far in our material prosperity and global footprint'. According to Schumacher, we should return to the small, the local, with more frugality and solidarity in family and neighbourhood (MNP-RIVM, 2004).
Currently, grassroots citizen initiatives and experiments are on the rise, for example, in local solutions for the provision of energy, food and care. (Groene Brein, 2020).

Alternative groups test various radical technological sustainability innovations in, for example, 'hackerspaces' and 'fabrication labs'. In these spaces and labs, technological grassroots experiments are carried out by technological experts and creative people. These alternative groups are striving to become more self-sufficient, which is why an open-source and sharing culture is often promoted. Initially, the funding for these spaces and labs comes from an outside source. However, staffing also relies on voluntary efforts (Hielscher et al., 2015). These hackerspaces and fabrication labs may be the birthplace of major advances in technology (Hielscher et al., 2015). Other alternative groups are formed by countercultural movements in 'Transition Towns'; they are a.o. searching for alternative spiritualities and lifestyles (Longhurst, 2015).

Firms are experimenting with a large variety of technological and social innovations and innovative sustainable business models. For several decades, there has been a growing awareness in firms that environmental and social aspects have to be included in business. Most innovations and new business models are concerned with generating economic returns. An emergent, more radical business model is the 'social enterprise not for profit', which is oriented towards resolving social and environmental issues and is not primarily concerned with profit making (Dentchev et al., 2016). While it is impossible to do full justice to the large bodies of literature available on these topics, we observe that a variety of innovative sustainable

business models have been introduced, such as new models for increasing the material and energy efficiency of production, the circular economy, the use of renewable resources, solutions for renting and sharing, fair trade, consuming less, social enterprises, and open-source innovations (Bocken et al., 2014). This true list of innovative models is certainly much longer and continues to grow.

Governments increasingly use experiments to address sustainability challenges, especially in cities. At present, city governments are increasingly confronted with a multiplicity of sustainability challenges, from carbon reduction to resource depletion and from austerity to maintaining social cohesion (Hodson et al., 2017). This multiplicity and complexity of challenges require a new approach. An element of the traditional approach was the 'survey-analysis-plan' approach, which resulted in policy plans that were updated every four or five years. In the new approach, there is much more room and appreciation for local experiments (Hajer, 2016). The new approach of experimentation, where innovative solutions are tested in practice-based experiments in real-life settings, is a promising way to gain traction in cities all over the world as a mode of governance to stimulate alternatives and steer change (Evans et al., 2016a).
Several authors give indications that these experiments with innovations are flourishing in distinct urban environments, such as in environments with creative people (Florida, 2002), with countercultures (Longhurst, 2015) or in campus environments (Kenney, 2003).

To summarise the observations on sustainability experimentation, there are (i) a variety of actors carrying out experiments, with (ii) various types of innovations, in (iii) a variety of urban environments. However, these experiments so far have not solved the major sustainability problems of our times; the absolute increase of the global greenhouse gas emissions in the past decade was the highest on record (IPCC, 2022), the biodiversity is being destroyed by humans at a rate unprecedented in history (WWF, 2020) and the overall emissions of reactive nitrogen continue to increase (CBD, 2020).

To solve these major problems, it is important that radical novel ideas to produce and consume with much less environmental impact are not only tried out in experimental settings but also diffuse at a large scale and by doing so change the current unsustainable practices that dominate our economic and societal system. Apparently, the diffusion of these innovations is problematic (OECD and World Bank, 2014). The road from experiment to large scale diffusion is full of obstacles. Literature on innovation systems has shown that these obstacles can be found at

different levels like the innovating organisation, the technology, the infrastructure, the demand side, and in the wider social and institutional context (Kemp et al. 1998). Barriers at these different levels impact each other, which leads to different types of blocking mechanisms (Jacobsson and Karltop, 2013).

To accelerate sustainability transitions, it is important that both experimentation with sustainability innovations and diffusion of these innovations takes place. This dissertation focuses on understanding the conditions that enable experimentation with sustainability innovations and the early diffusion of these innovations. First, we will examine previous research to obtain insight into what is already known about these topics and what the research gap is.

1.3 Previous research

In this section, we examine the relevant literature on the topic of experimentation with sustainability innovations and the diffusion of these innovations. Primarily, we consult the literature on transition studies. Since we suspect that the type of urban context is important, we also use regional innovation systems research. Finally, we also consult the field of the geography of transitions research, in which insights from transition studies and regional innovation systems research are combined.

Transition studies

In *transition studies*, the multi-level perspective suggests that a large system change may start small, for example, in sustainability experiments with innovations in distinct ‘spaces’. These spaces are called *niches* (Schot and Geels, 2008). The literature indicates that this emergence of experiments may be the starting point of a diffusion process, where innovations gain more users. These innovations may challenge the structures of the *regime*, i.e., the structures of existing systems in societal domains, such as in the provisioning systems for energy or food. These structures contain the rule-set of the current institutions and infrastructures, such as existing perspectives, ways of thinking, routines, and legislation (Rotmans and Loorbach, 2010). The *landscape* contains deep structural trends, such as oil prices, economic growth, general cultural values and environmental problems. The landscape is different from the regime; it may put pressure on the regime, which creates openings for innovations at the niche level (Geels, 2002). In the longer term, these processes may eventually lead to system change (Geels and Raven, 2006).

In transition studies, a sustainability experiment is defined as ‘an inclusive, practice-based and challenge-led initiative designed to promote system innovation through

social learning under conditions of uncertainty and ambiguity' (Sengers et al., 2019). This research adopts this definition.

Within transition studies, the *strategic niche management* concept is developed to analyse sustainability experiments and to identify the conditions that enable the diffusion of these experiment-based innovations towards a possible system change. A niche is considered a protective space that allows for experimentation, nurturing processes and shielding (Schot and Geels, 2008). This protection is needed to prevent those innovations from being exposed to the harsh selection pressures of the existing regime (Sengers et al., 2016). The phases of experimentation and early diffusion are both considered part of experiments in niches (Geels, 2019).

Sustainability experiments may be the starting point of a diffusion process of the innovation. In the early diffusion phase, the innovation is still in the prototype phase, and the experiments build on each other through, for example, learning processes between developers, users and other pioneers (Geels, 2019). This diffusion process is critical for sustainability transitions to take place. It is supported through various mechanisms, such as scaling up (the innovation is expanding in geographical scope and duration), replication (the experiment with an innovation is repeated in a new context or location), circulation (the innovation is embedded in an ongoing transformation process of existing regimes, for instance, by generating noncontrolled flows of ideas) and institutionalisation (the innovation becomes part of regime structures); see Turnheim et al. (2018). However, it is known that this diffusion is problematic (OECD and World Bank, 2014).

In the transition studies literature, three factors are generally recognised for the successful development of a niche: the articulation of a vision, the development of social networks and learning processes at various dimensions (Schot and Geels, 2008). We will use these factors in this research and attempt to articulate them geographically. Additionally, the recent insight has been gained that even though the diffusion of innovations takes place in the future, it is already possible to improve the 'transformative potential' during experimentation (Ghosh et al., 2021; Wolfram et al., 2019).

From the literature, it is also clear that in analysing the factors for niche development, it is necessary to make a distinction between guided and grassroots experiments. Guided experiments are coordinated by governments or firms. These experiments are enabled by a clear vision or a strong economic specialisation (Hansen and Coenen, 2015). A vision may function as a selection environment for experiments

and development pathways (Hekkert et al., 2007). Grassroots experiments are emerging bottom-up, at least from the perspective of governments. They are self-governed by civil society, which consists of e.g., voluntary associations, cooperatives, and informal community groups. These experiments are often more loosely structured and do not always result in formally documented institutional learning. Learning is tacitly held within people rather than consolidated in readily accessible forms. This limited learning and the inward orientation of the experiments make scaling up difficult (Seyfang and Smith, 2007; De Moor, 2013).

In transition studies a niche is not geographically articulated. However, there are several indications that sustainability experimentation and diffusion show a large spatial unevenness between countries and regions (Feola and Butt, 2017, Monstadt, 2007). This unevenness suggests that the geographical context matters in sustainability transitions (Hansen and Coenen, 2015). A new research field emerged: the geography of transitions research. We will first examine regional innovation systems research because this field is an important source for the geography of transitions research.

Regional innovation systems research

Regional innovation systems (RIS) research is mainly focused on innovations developed by firms. In our research, we are also interested in other actors; however, the main concepts from RIS research can be used.

The RIS literature offers an important insight: geographically, innovation activity is not evenly distributed between or within countries. Spatial clustering of innovations occurs in knowledge-intensive regions where firms and research institutes profit from agglomeration economies (Duranton and Puga, 2004).

Cities and urban regions offer important conditions that enable the development of innovations, such as geographical proximity of the actors involved and knowledge spill-overs, i.e., the larger opportunities for productive knowledge exchange among firms and research institutes (Boschma, 2005; van Oort and Bosma, 2012, Jaffe et al., 1993). Additionally, regional capabilities are important for learning and the development of innovations. These capabilities are formed by the general human and physical resources and by the knowledge and skill base that are embedded in their industrial and institutional structures (Neffke et al., 2011). Various researchers emphasise that it is important that these conditions are present in combination (Aydalot, 1986). In a regional innovation system, these elements are integrated, including the institutional and organisational support structures (Asheim et al., 2016).

From the RIS literature, we learn that experiments focused on technological

innovations are different from experiments primarily focused on social innovations. The knowledge involved varies widely. Experiments with technological innovations deal with technological inventions. They are often science-dominated and use codified knowledge (Malerba, 2005), which may be easy to transfer to subsequent experiments. Experiments with social innovations deal with new ways of finding solutions for societal challenges; they also deal with behavioural change. They are often supplier-dominated and use tacit knowledge (Moulaert and Nussbaumer, 2005). Part of this knowledge may consist of symbolic knowledge, which is strongly tied to the habits and norms of social groups (Asheim et al., 2007); this knowledge is more difficult to transfer to subsequent experiments.

Furthermore, cities and regions may be the right scale for an 'intermediate' actor level between national and global policies on the one hand, and local practice on the other hand (Grubler et al., 2012). On this scale, it is possible to translate these policies into practice-based experiments, for example, in a living lab setting. Such labs offer beneficial preconditions (such as a real-life context) to advance transitions (Almirall and Wareham, 2008; Schliwa and McCormick, 2016).

In the city-regions in Europe, large cultural differences are observed; this may shape localised densities of experimentation patterns in a diversity of innovative milieus (Kaasa, 2016). These cultural differences, such as a high openness to new ideas or a low acceptance of power inequalities in institutions, may enable the development of innovations. Hofstede (1980) showed that these cultural differences may have originated centuries ago, for example, from differences between countries and regions that were or were not part of the former Roman Empire (which had strong power inequalities). These findings give an impression of the existence of strong path dependencies in context conditions for the development of innovations.

Despite this localised character of innovation activities, an important question in this research field remains whether successful innovation activities may be explained mainly by the micro or by the meso/macro scale, i.e., by project-internal factors or by regional and national context factors (see, for instance, Raspe and van Oort, 2011).

Geography of transitions research

In the emerging field of the *geography of transitions research*, insights from transition studies and regional innovation systems research are combined. The core question in this research field is where new developments for sustainability are likely to take place and 'which sort of local contexts are amenable to the creation of novel

configurations that work', i.e., configurations that could be taken up at a regional and national scale (Truffer, 2016). The research in this dissertation is positioned in this new field.

The geography of transitions research is mainly focused on cities. Currently, cities have emerged as the dominant space for addressing large sustainability challenges. Problems associated with, for instance, climate change and the circular economy are essentially urban in character, as are their solutions (Evans et al., 2016a).

The geographical unevenness in innovation activities found in RIS research is also found by some researchers in the geography of transitions research. For example, the diffusion of Transition Town initiatives shows a large spatial unevenness between countries and regions (Feola and Butt, 2017). In 2014, Hansen and Coenen stated that 'the geographical context and scale matter in sustainability transitions, but there is little knowledge on how context and scale matter' (Hansen and Coenen, 2015). A related but yet unanswered question is whether distinct regions may act as 'frontrunner regions', i.e. as regions with favourable spatial context conditions for experimentation and diffusion, thereby acting as examples for (other pioneers in) other locations.

Since 2014, the literature in the field of the geography of transitions has expanded considerably. Additional indications have been found that the spatial context and scale matter in the emergence of experiments with sustainability innovations and their diffusion, but the available knowledge is still fragmented, and a thorough theoretical basis is still lacking. Most of the research in this field entails a single case study, for instance, research on an 'alternative' village or city, such as an intentional community (Fois, 2016), a Transition Town (Longhurst, 2015) or a 'green' city (Torrens et al., 2018). In these villages and cities, countercultural movements play an important role in shaping a beneficial context for experimentation through alternative ideas and lifestyles (Longhurst, 2015). Others have analysed larger cities, such as Berlin and Barcelona. Berlin is known for its leading role in urban energy transitions; this was explained by having privileged locational factors that other cities do not have (such as a high number of R&D institutions and easier access to information flows, see Monstadt, 2007). Barcelona is known for its fabrication labs, which are related to the ambition of the city to become a 'fab city' (Hielscher et al., 2015).

In quantitative studies, the most important spatial context conditions found are the membership of transnational city networks (Castan Broto and Bulkeley, 2013; Davies

et al. 2017), the relationship with university towns (Davies et al. (2017), a supportive government (Davies et al. 2017; Feola and Butt, 2017), gentrifying and income-deprived neighbourhoods (Håkansson, 2019) and vibrant environments such as fairs and conferences (Feola and Butt, 2017).
Irvine and Bai (2019) analysed a frontrunner city, which they define as a city engaged with ongoing sustainability experimentation and often becoming a beacon for others to follow.

As a summary of the previous literature, we observe that:

- The existing transition studies literature shows that several conditions are important for the development of a niche and the early diffusion of the novelty developed within the niche. However, these conditions are not geographically articulated. The literature from the emerging field of the geography of transitions is promising in making this geographical articulation, but the available knowledge on this topic is still fragmented.
- In the RIS literature, various spatial context conditions are identified that enable innovation, but it is not clear whether these conditions are also valid for sustainability innovations. This is because RIS research is focused on economic innovations developed in firms with market potential. It is uncertain whether this potential is also present for sustainability innovations.

There is a considerable gap in our knowledge: a systematic analysis of the mechanisms and the distinct (combinations of) spatial context conditions that enable sustainability experimentation and early diffusion is not available. Closing this gap can be valuable for practitioners and supportive of accelerating sustainability transitions.

1.4 Research questions

In this dissertation, the following overall research questions are addressed:

- *Which spatial context conditions enable practice-based experiments with sustainability innovations in Europe and the early diffusion of these innovations?*
- *How can these conditions be improved?*
- *In which type of city-regions are these conditions favourable?*

These research questions are elaborated into four detailed questions:

- The first question concerns the spatial context conditions that enable sustainability experimentation. The question is as follows: What are the major success factors, barriers and diffusion[1] mechanisms of European sustainability experiments in their geographical context? This question is answered in Chapter 2.
- The second question concerns the spatial context conditions that enable sustainability experimentation in four distinct city-regions in Europe and the possibility of improving these conditions. The question is as follows: Which spatial context factors enable the future diffusion of sustainability experiments in contrasting regional habitats in Europe, and can these factors be positively influenced? Habitats are defined as configurations of local and regional context factors that enable experimentation. This question is answered in Chapter 3. This research builds on Chapter 2 by a qualitative deepening.
- The third question concerns the spatial context conditions that enable the early diffusion of sustainability innovations. The question is as follows: What are the pathways for the transfer of sustainability innovations to other locations, and how do local and regional contexts enable this transfer? This question is answered in Chapter 4.
- The fourth question is about the spatial context conditions that enable experimentation and early diffusion and about the type of city-regions in which these conditions are favourable. The question is as follows: which project-internal and context conditions enable the translocal diffusion of sustainability innovations in Europe, and which type of city-regions in Europe are frontrunners in this diffusion? This question is answered in Chapter 5. This research is a synthesis of the concepts developed in Chapters 2, 3 and 4.

This research has the following delineation:

- The focus of this research is on practice-based experimentation with innovations in a real-life setting, mostly in urban areas, in projects that want to break with the existing regime (i.e., the rule-set of the current institutions and infrastructures). We selected experiments geared to 'stretch and transform' the current system

[1] In the original papers from Chapter 2 and 3, the term ‘upscaling’ was used, instead of diffusion. However, in this dissertation we use the framework from Turnheim et al. (2018), which was published after the publication of Chapter 2 and 3. Upscaling in Chapter 2 and 3 covers the diffusion mechanisms ‘upscaling’ and ‘replication’ in the framework of Turnheim et al.

and the vested interests, rather than those geared to 'fit and conform' with the existing regime (Smith and Raven, 2012). Furthermore, in the case selection, we selected the cases along two dimensions: experiments with technological innovations versus experiments with social innovations and guided experiments (guided by, for example, governments or firms) versus grassroots experiments (carried out by, for example, citizen groups). These two dimensions are used because the literature shows that they are relevant to analysing the context conditions that enable experimentation.

- When analysing the conditions for experimentation, we focus on the transformative potential of the innovations; we are thus interested in the conditions that enable the future diffusion of the innovations.
- Experimentation can be carried out in coevolution with its spatial context. This principle, originally stemming from biology, where species and habitat coevolve, is also known in transition research (Schot and Geels, 2008), although not in a geographically explicit form. Coevolution suggests that the context can improve experimentation, and at the same time, by experimenting, the context can improve. That it is possible to improve the context by experimentation was suggested by Schot and Geels (2007), who stated that ‘innovations construct their own niches’. In our research, the habitat concept will be developed to analyse this coevolution between experiments and a configuration of spatial context factors.
- The focus is on the transition phases of experimentation and early diffusion. In these phases, the innovation is still in the prototype stage. This research is therefore focused on the diffusion of innovations between developers, users and other pioneers and not on mass diffusion to the global market or society. This implies that the full transition process is only partly analysed.
- When analysing diffusion, we focus on the translocal diffusion of innovations, i.e., the repetition and reproduction of an experiment in a new context, such as a new city or country (Turnheim et al., 2018).
- This research especially investigates the spatial *context* conditions. Project-internal conditions are included in this research to estimate their relative share in explaining experimentation and early diffusion and to control for them in determining the spatial context effects.
- In this research, an inventory of spatial context conditions is made based on previous literature from transition studies and RIS. Our approach is not limited to the concept of a ‘protective space’, which is often used in transition studies (Smith and Raven, 2012). We use a broader approach because we do not a priori assume that these conditions are connected to ‘protection’. This broader approach is similar to that used by Torrens (2019).

- Regarding issues of scale, the RIS literature shows that the conditions present on the local and regional scales are of central importance for explaining diffusion. At the start of this research, however, it was not clear whether these conditions found in the RIS literature were also valid for experimentation with sustainability innovations and the diffusion of these innovations. In the interviews of the qualitative research (Chapter 2) and of the comparative case studies (Chapters 3 and 4), we, therefore, are interested in contextual factors on all scales from local to global. In Chapter 5, we build on the results of Chapters 2, 3 and 4. The results of Chapters 2, 3 and 4 confirmed that the local and regional scales are important for sustainability innovations. In Chapter 5, it was therefore decided to use indicators mostly on these scales in the analysis.
- Two diffusion mechanisms are analysed: scaling up (i.e., expanding the geographical scope of the innovation) and replication (i.e., the experiment with an innovation is repeated in a new context or location). In this research, we did not explicitly analyse two other diffusion mechanisms as proposed by Turnheim et al. (2018), i.e., circulation and institutionalisation.
- In this research, it is important for us to obtain insights that are relevant to the practice of supporting sustainability experiments; thus, we include practical policy recommendations.

1.5 Conceptual framework and hypotheses

We use the literature to construct a simple conceptual framework; see Fig. 1.1.
From the literature, we know that the phase of experimentation with innovations and the phase of the diffusion of these innovations is a major challenge (Kemp et al., 1998). The conditions that enable these two phases of transitions are of interest in this research; these phases shape the horizontal dimension of the framework.
To analyse these conditions, an important question in the regional innovation systems literature is whether successful innovation may be explained mainly by the micro or macro scale, i.e., by project-internal factors or by spatial context factors (Raspe and van Oort, 2013). The literature indicates that these spatial context conditions are mainly present on the local and regional scales, which is labelled the ‘region’ in the framework.

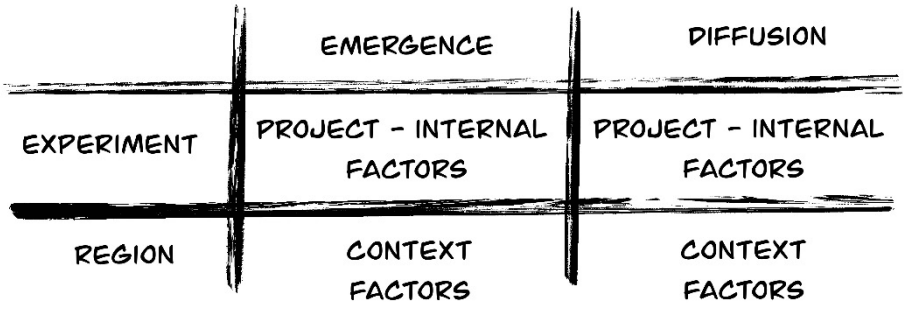


Fig. 1.1. Conceptual framework

The combination of the bodies of literature used in this research allows us to test the following main hypotheses in the various chapters of this dissertation:

1. The literature indicates that in analysing experimentation, it is relevant to discriminate guided from grassroots experiments and experiments for technological innovation from social innovation. *Guided experiments* are coordinated by governments or firms. These experiments are enabled by a clear regional vision or a strong economic specialisation (Hansen and Coenen, 2015). *Grassroots experiments* emerge from the bottom-up. They are self-governed by civil society; they consist of e.g., voluntary associations, cooperatives, and informal community groups. The small scale and geographical rootedness make scaling up difficult (Seyfang and Smith, 2007). Experiments for *technological innovation* deal with technological inventions. They are often science-dominated and use codified knowledge (Malerba, 2005). Experiments for *social innovation* deal with new ways of finding solutions for societal challenges; they also deal with behavioural change. They are often supplier-dominated and use tacit knowledge (Moulaert and Nussbaumer, 2005). This literature leads to the hypothesis that various types of experiments have distinctive favourable 'habitats', i.e., configurations of local and regional context factors that enable experimentation (this will be tested in Chapters 2 and 3).
2. The literature indicates that differences between social and technological innovations must be taken into account in analysing diffusion. Experiments with technological innovations use codified knowledge (Malerba, 2005), which may be easy to transfer to subsequent experiments. Experiments with social innovations use tacit knowledge (Moulaert and Nussbaumer, 2005), which is more difficult to transfer to subsequent experiments. We put forward the hypothesis that

experiments for social and technological innovation will have different transfer pathways by which these innovations diffuse translocally. We also expect that the diffusion of innovations is facilitated by a 'harbour', i.e., a combination of local and regional context conditions that enable transfer (will be tested in Chapter 4).

3. The geography of transitions literature indicates that there are various spatial context conditions that enable experimentation and diffusion, such as the membership of transnational city networks (Castan Broto and Bulkeley, 2013; Davies et al. 2017), the relationship with university towns (Davies et al. (2017), a supportive government (Davies et al. 2017; Feola and Butt, 2017), gentrifying and income-deprived neighbourhoods (Håkansson, 2019) and vibrant environments such as fairs and conferences (Feola and Butt, 2017). The hypothesis is put forward that frontrunner regions for sustainability experimentation and diffusion host a countercultural milieu, a high number of network connections (supported by a culture of openness, trust, and shared sustainability values), a vibrant environment and the presence of a few distinct actors (will be tested in Chapter 5).

1.6 Methodology and case selection

At the start of this study, there was hardly any empirical research available regarding the spatial context factors that enable sustainability experimentation. Most existing research entailed single case studies, such as on a Transition Town (Longhurst, 2015) or on an intentional community (Fois, 2016). The research on climate experiments by Castán Broto and Bulkeley (2013) was one of the few quantitative studies available.

Thus, this research is one of the first to systematically analyse the spatial context factors for sustainability experimentation. Therefore, we opted for a research design that starts with a broad qualitative analysis (Chapter 2). Then, we chose a qualitative deepening through comparative case studies (Chapters 3 and 4), supplemented with an action-oriented workshop (Chapter 3) and a systematic literature review (Chapter 4). Finally, a quantitative analysis was applied with a large dataset (Chapter 5). These different methods were chosen to enable triangulation to validate the findings by comparing the outcomes of the literature review and the qualitative and quantitative research (Bryman, 2012).

Case selection

The dissertation case selection entailed searching for cases related to the 'radical

incrementalism' approach, in which people share the view that a radical transition is needed, without assuming that a classical revolution is necessary. They tend to share the assumption that the transition may be realised along an incremental path, by carrying out practise-based experiments (Swilling, 2020). Within the enormous diversity of sustainability experiments available, in this research, practice-based experiments were selected that want to break with the existing regime, i.e., we selected experiments geared to 'stretch and transform' the current system and the vested interests, rather than experiments geared to 'fit and conform' the existing regime (Smith and Raven, 2012). Therefore, the case selection criterion was that the projects have an experimental character, i.e., a prototype should be available that may have been tested a few times, but there should still be uncertainty regarding whether it will work in real life and whether it will be embedded in the regime. In addition, we did not necessarily search for innovations that were ‘new for the world’ but for innovations ‘new for the region’ (Binz and Gong, 2021).

In Chapter 2, a large variety of cases was selected within a diversity of spatial contexts. We selected 56 projects in the sectors of energy, mobility and agrifood in urban as well as rural areas in 14 countries in Europe.
Chapters 3 and 4 were built on the research of Chapter 2. This research focused on four distinct city-regions in different European countries. In a comparative case study, the factors for experimentation (Chapter 3, n=39) and early diffusion (Chapter 4, n=48) were analysed. In these cities, projects were selected based on archetypical experimentation patterns of distinct configurations in local and regional context factors for experimentation (the ‘habitats’), shaped along two analytical dimensions of experiments: differences between experiments for technological and for social innovations and the differences between guided (for example, by governments or firms) and grassroots experiments (carried out by, for example, citizen groups), assuming that these differences are relevant in the context conditions that enable experimentation and early diffusion (see Fig. 1.2).

Fig. 1.2. Summary of the selected cases in Chapters 3 and 4

Finally, to obtain more evidence regarding the conditions for experimentation and diffusion, a quantitative analysis was carried out; see Chapter 5. A large dataset of nature-based solutions in Europe was used. The dataset covers 472 experiments in 99 cities in 89 regions in Europe. A logistic regression analysis was executed, with a large number of project-internal and regional context variables that may explain the diffusion of nature-based solutions towards successive experiments.

1.7 Dissertation outline

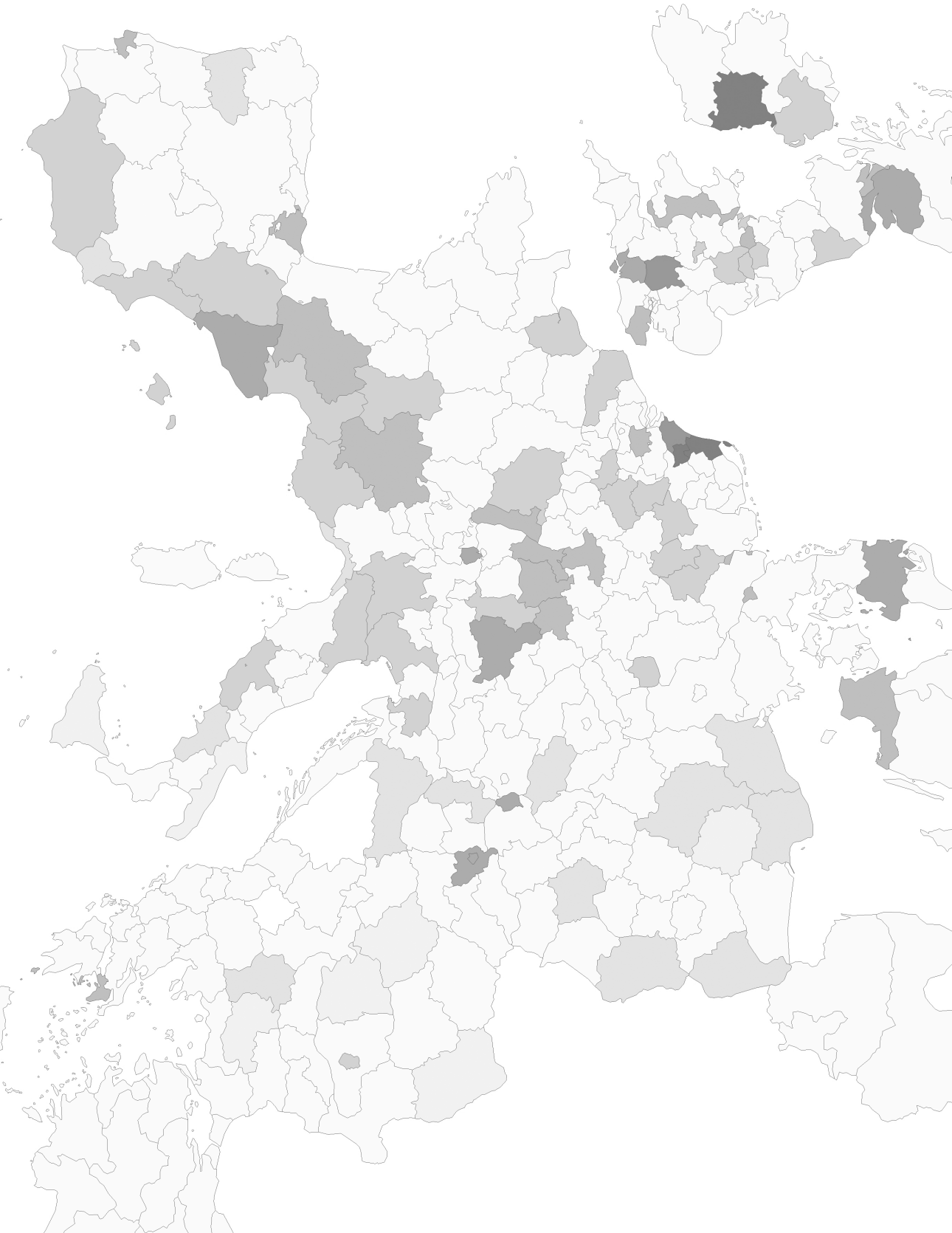
The structure of this dissertation is summarised in Table 1.1. Both the phase of experimentation and the phase of early diffusion are presented. The main concepts are developed and elaborated further in the successive chapters. In the empirical work, a variety of research methods were used to allow for triangulation. In Chapter 5, we synthesise the concepts and build on the findings from the earlier chapters and from other literature.

The dissertation proceeds as follows. In Chapter 2, the different types of sustainability experiments are unravelled in a variety of distinct favourable contexts in which they take place. In Chapter 3, we further explore these contexts that enable experimentation in four city-regions in Europe. In Chapter 4, the focus is shifted to the contexts that enable the early diffusion of innovations. In Chapter 5, the concepts for experimentation and early diffusion are synthesised, and a quantitative analysis of a large number of projects in 89 regions in Europe is carried out. A preliminary index is developed, which gives insight into the so-called frontrunner regions for

sustainability experimentation in Europe. In Chapter 6, we summarise the results, draw conclusions and reflect on issues such as the generalisability of the results, issues of scale, our recommendations for practitioners and some suggestions for avenues for further research.

Table 1.1. Structure of the dissertation

Chapter	Transition phase analysed	Concept developed	Methods used	Cases selected
2	Experimentation	Habitat	Qualitative	Variety of experiments and contexts (n=56)
3	Experimentation	Habitat (further elaboration towards archetypical experimentation patterns)	Comparative case study (including action-oriented workshop)	Experiments in four city-regions (n=39)
4	Early diffusion	Harbour	Comparative case study (including systematic literature review)	Experiments in four city-regions, same as above, including 'receiving' cases (n=48)
5	Synthesis: experimentation and early diffusion	Synthesis: habitat and harbour	Quantitative (regression analysis)	99 cities (n=472)



Chapter 2

A habitat for sustainability experiments: Success factors for innovations in their local and regional contexts

Abstract

The sustainability challenge requires various forms of experimentation with inventions, which may lead to an upscaling process in which the invention and its applications will spread to other users and regions in the world. However, many experiments fail. In this Chapter, we explore the success factors for sustainability experiments in their contribution to a longer-term regime change. These factors are related to the experiment itself as well as to the habitat in which the experiment takes place. A habitat is regarded as a configuration of contextual factors, which are mainly locally or regionally embedded. We introduce complementary insights from transition management literature and regional innovation systems literature to hypothesise that various types of experiments have distinctive favourite habitats, each with their specific success factors. Our exploratory survey among 56 sustainability experiments throughout Europe in the area of food, mobility and energy innovation suggests that user involvement is the most important success factor. Other important factors are the cooperation in local and regional networks, the policy instruments from the local and regional government, the dissemination of learning experiences, and the existence of a local or regional vision of the future. We conclude that entrepreneurs, users, local and regional governments as well as other regional partners should collaborate actively to make sustainability experiments more successful.

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2.1 Introduction

Sustainable development is one of the crucial societal challenges of our times. On a global scale, issues such as food security, poverty, climate change, water availability, and biodiversity demand urgent attention. On national and regional scales, food, mobility and energy systems can be greatly improved. To accommodate these challenges, however, transitions are needed, i.e. large-scale societal changes that take several decades to complete. An important element in the transition process is the experimentation phase. In this phase, inventions are tested in specific local and regional contexts. In society and policy, there are high expectations that successful experiments will stimulate both upscaling mechanisms and the economic viability of the innovations needed in the transition process. In this upscaling process, the invention is improved and diffused to other locations and regions in the world, which may lead to the necessary transition. However, in reality these upscaling mechanisms often do not materialise. Worldwide, thousands of sustainability experiments have been carried out, but many have actually failed, i.e. they do not scale up (OECD & World Bank, 2014). There is a clear societal need to gain insight into the success factors of sustainability experiments in their contribution to upscaling towards a longer-term regime change.
Crucial for understanding both the success of experiments and upscaling opportunities are the conceptualisations of success and of conditioning spatial embedding circumstances. This Chapter wants to contribute to both these issues, using conceptually informed empirical research.
Complementary to the present transition literature, we introduce a broad definition of experiment success, distinguishing two dimensions:

a. success in the short term, i.e. whether the experiment achieves its short-term targets;
b. success in the long term, i.e. whether the experiment contributes to upscaling to a longer-term regime change.

We introduce such a broad definition because both dimensions of success are probably linked: short-term success may trigger long-term success. Alternatively, we may learn from an experiment that fails to achieve its short-term targets but still contributes to a longer-term regime change.
In this Chapter we develop the notion that the experimentation phase in sustainability transitions is a crucial phase. In this phase (between prototype and upscaling), a prototype is made available, but it is not yet clear whether the innovation will scale

up. We define upscaling of transition experiments as (i) an increase in the number of users and (ii) the embedding of experiments in the existing structures of the regime, i.e. perspectives, ways of thinking, routines, legislation and institutions (Rotmans and Loorbach, 2010). The increase in the number of users may occur either in the region in which the experiment has been embedded or elsewhere, given the cognitive understanding of innovation (Ponds et al., 2010).

Some transition management research focuses on the identification of the success factors for sustainability experiments. However, in this research tradition the geographical dimension is initially lacking. The geography is relevant because transition processes are unevenly distributed in space: they initiate in and diffuse to some places more than to other places (Hansen and Coenen, 2015; Boschma, 2005). By focusing on the success factors of an experiment as well as on the geographical context of the experiment (the habitat), we shed light on the hypothesis that local and regional environments potentially contribute to experiment success. Originally stemming from biology, we introduce the habitat concept in transition research to suggest that experimentation is carried out in co-evolution with its geographical context. In transition research, the process of co-evolution is well known (e.g. Schot and Geels, 2008), although not in a geographically explicit form. Furthermore, we suggest that various functional types of habitats may overlap in a geographical sense.

Our research question is the following: what are the major success factors, barriers and upscaling mechanisms of European sustainability experiments in their geographical context? A focus on the European dimension warrants the capturing of heterogeneity in local and regional contexts, such as institutional variations in structural change processes (Cortinovis et al., 2017) and variations in place-based and regional policies (Barca et al., 2012). We zoom in on the local and regional contexts across European countries, but we are interested in factors on all scales from local to global. Regions are a particular unit at which innovative experimentation occurs, because of for instance the (skilled) labour market and institutional and policy conditions. In this Chapter we focus on sustainability experiments in living labs, which offer promising preconditions for success. In relation to this, we focus on success factors contributing to upscaling towards a longer-term regime change. With respect to the upscaling mechanism, we focus on two aspects: the links with previous and the following experiments and the dedicated activities carried out in the experiment to promote future upscaling.

Scientifically, we aim at making an empirical contribution to the emerging field of the geography of transitions. We address the research gap on how the geographical context and scale matter in sustainability experimentation. From a societal perspective, this research is aimed at bringing relevant insights to the stakeholders

involved in sustainability experimentation. These insights may be used to enhance the success of sustainability experiments in future.

2.2 Background

Several bodies of literature address topics relevant to answering our research question. We argue that it is necessary to combine insights from two different research fields: the transition management literature (TM), which addresses sustainability experiments, especially concerning strategic niche management (SNM), and the regional innovation system literature (RIS), which explicitly focuses on the geographical context of innovation. The combination of these two bodies of literature generates complementary insights.

2.2.1 Transition management

In the TM and SNM literature, two concepts are relevant to our research: the multi-level perspective and the multi-phase model. In the multi-level perspective, a novelty is created on the niche level (a novelty is called an invention in innovation literature). A transition process occurs if the novelty, which emerges on the niche level, enters the regime, spurred by changing landscape level conditions (Geels, 2002). We consider a niche a space where experimentation is carried out. However, the geographical dimensions of this space are not defined in transition literature.
The multi-phase model is different from the multi-level perspective, and describes the various phases in transitions. Experimentation and learning predominantly occur in the take-off phase. We are interested in the factors that facilitate the upscaling of experiments. These upscaling processes occur in the next phase, i.e. the breakthrough phase (Rotmans et al., 2001).
In the SNM literature, an experiment has a specific set of meanings related to the seeds of change that may lead to a transformation in the way in which human needs are met (Sengers et al., 2016). A sustainability experiment is sometimes also defined as a purposive and strategic intervention that explicitly seeks to capture new forms of learning or experience (Castán Broto and Bulkeley, 2013). In other words, sustainability experiments are focused on a future goal.
Experimentation and possibly subsequent upscaling are not simple linear processes. There is a high level of risk involved in terms of failure (Rotmans, 2005). Upscaling requires series of transition experiments in various niches (Raven et al., 2010). In these niches, various processes of nurturing and empowering are needed (Smith and Raven, 2012).

In the SNM literature, the success of a sustainability experiment is often defined as the increased possibility of scaling up the experiment in future (e.g. Kemp et al., 1998). This is the key challenge for sustainability experiments. As indicated in Section 2.1, we use a broader definition of success in this study.

An imitation of real-life conditions in so-called living labs may help sustainability experiments become successful. Such labs offer beneficial preconditions (i.e. user involvement, real-life settings and a formal evaluation) to advance transitions (Almirall and Wareham, 2008; Schliwa and McCormick, 2016).

In practice, we observe that individual experiments are not isolated events, but build on each other over time. Geels and Raven (2006) conceptualise how the local outcomes of an experiment are transformed into generic lessons by aggregation activities, in which conferences, workshops and journals and so on play a role (see Fig. 2.1). For these aggregation activities, intermediary actors at the community level (e.g. branch organisations) are important (Geels and Deuten, 2006). In such a 'learning trajectory' there may be an individual project that fails. Still, a failing project may constitute a positive contribution to an overall learning trajectory (Geels and Schot, 2010).

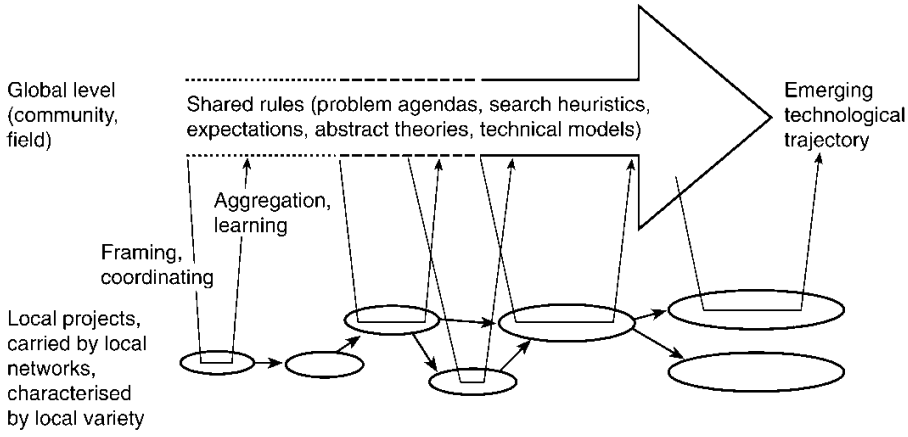

Fig. 2.1. Technical trajectory carried by local projects (Geels and Raven, 2006).

Success factors for upscaling to regime change

The success factors for the upscaling of sustainability experiments have been studied by transition scholars. However, their work mostly focuses on technological innovations. More in detail they focus on the success factors for the emergence of a technological niche towards a market niche (Hoogma et al., 2002; Kemp et al., 1998). Three success factors are generally recognised:

- the articulation of expectations and visions. Successful niches have visions which are: (i) shared by many actors, (ii) specific and (iii) of high quality
- building of social networks. Successful niches have (i) broad networks and (ii) deep networks.
- learning processes at various dimensions, i.e. first order learning (maintenance learning) and second order learning (reframing, or reordering of assumptions; Sterling, 2007).

In the literature, there are some indications that the upscaling of sustainability innovations is more difficult than the upscaling of innovations in general. Often, there is no relative advantage for the user (Rogers, 2003). A sustainability niche requires a protective space that allows for nurturing and experimentation (Schot and Geels, 2008). Such a niche is a space where radical innovations can develop without being subjected to the harsh selection pressures of the prevailing regime (Sengers et al., 2016). Selection pressures include technical standards and market rules (see Smith and Raven (2012) for an extensive discussion). The RIS literature includes some research related to protective spaces. The hypothesis that local nursery and adoption circumstances of experiments are crucial for their success has been formulated and tested before (Duranton and Puga, 2001).
As argued above, the geographical dimension was initially lacking in the TM and SNM literature, even though it is inherently important for explaining the success of an experiment. For this dimension, we make use of the literature on regional innovation systems.

2.2.2 Regional innovation systems

The regional innovation systems (RIS) literature offers an important insight that is relevant to our research question: geographically, innovation activity is not evenly distributed among and within countries. Spatial clustering of innovation occurs in knowledge-intensive regions where firms and research institutes profit from agglomeration economies (e.g. by matching labour demand and supply, sharing common specialised input and generic infrastructures, and gaining learning opportunities from cooperation partners and competitor, Duranton and Puga, 2004). Besides urban advantages of density in production and consumption, the learning opportunities in the cooperation structures of firms, research institutes and governments − the so-called triple helix − constitutes an innovation system (Asheim and Gertler, 2006). Recently, society at large has been seen as the fourth dimension in innovation systems, as origin and adaptation of new applications increasingly stem

from self-organised initiatives at individual levels that generally lack upscaling resources. In regional innovation systems, the institutional arrangements and conditions are crucial for creating an innovative and growth-oriented economic climate; yet, it is often argued that governments facilitate important conditions (in safety, funding, education, accessibility, housing and amenities), whereas firms and research organisations become members of innovative cooperation networks (Cooke et al., 2004; Chesbrough, 2003). From the RIS literature we can distil three factors that hypothetically provide an explanation for the differences between locations and regions with respect to their innovative activities. These factors are proximity, knowledge spillovers and regional capabilities.

Five dimensions of proximity may be distinguished: organisational, social, institutional, geographical and cognitive proximity (Boschma, 2005). Learning processes and innovation are facilitated by geographical proximity, as co-location fosters face-to-face contacts and reduces the risks and uncertainties in economic relations. However, other forms of proximity may reinforce local clustering of learning processes but may also imply learning relationships over larger distances. Learning in cooperation networks builds on mutual cognitive understandings: on the sharing of technologies, on market orientation, on types of business models, and on mutual trust and habits in niche markets (Boschma, 2005). In search of the optimal cognitive proximity of firms, governmental agencies and research institutes, it is necessary that there is a delicate balance in common understanding. If there is insufficient cognitive proximity, firms may be unable to learn from each other; however, if there is too much cognitive proximity, this may lead to lock-out from community-external developments (Nooteboom, 2000). Other forms of proximity may coincide with this, like social network relatedness, institutional similarities (both formally and informally defined; see Cortinovis et al., 2017) or organisational relatedness (in terms of ownership, the business models applied and legal forms of organisation). Invention and learning processes can profit from other types of proximity in addition to or coinciding with geographical proximity (Cooke et al., 2004; Asheim and Gertler, 2006). This builds trust.

Knowledge spillovers are also important; these are the larger opportunities of productive knowledge exchange among firms and research institutes in dense, mostly urban areas (Jaffe et al., 1993). These spillovers are tacit, and therefore geographical proximity facilitating face-to-face contact is important (Van Oort and Bosma, 2012). Similar to the proximity conceptualisation, this tacit knowledge is often created by social learning, i.e. by interactions between firms, knowledge institutions and government, and also by interactions between producers and users (Asheim and Gertler, 2006). Research emphasises that specific knowledge is neither equally accessible nor equally relevant to economic actors (Nooteboom, 2000).

Finally, regional capabilities are important for learning and innovation. These capabilities are formed by the general human and physical resources, and by the knowledge and skill base that are embedded in their industrial and institutional structure. These capabilities are difficult to imitate by other regions as they often build on previous stocks and diversification of the skill bases present in these regions (Neffke et al., 2011). The regional capability to produce and use knowledge are key to success (Cooke et al., 2004), as it contributes to developing effective organisations, facilitates collaboration between firms, governments and knowledge institutes and increasingly also between these stakeholders and society at large, and contributes to the upgrading skills needed for innovative and productive activities. Knowledge-based institutional assets are closely related to these capabilities (Gertler and Wolfe, 2004).
These factors from the RIS literature may help us find geographically explicit success factors for sustainability experiments, which we can use as the basis for our empirical work. This is described in Section 2.2.4 below.

2.2.3 Towards the combination of factors from TM and RIS

The combination of TM and RIS literature allows us to better understand the success factors for sustainability experiments in their geographical contexts. Since these two bodies of literature represent rather distinct lines of research, combining them is not an easy task. TM literature is based on the multi-level perspective, whereas RIS literature is primarily based on the theory of competitive advantage of regions. However, two studies have recently been undertaken that may be regarded as the first step towards the combination of TM and RIS literature. One deals with the geography of transitions (Hansen and Coenen, 2015) and the other discusses sustainability experiments (Sengers et al., 2016).
Hansen and Coenen (2015) reviewed the literature on the geography of transitions. They conclude that the geographical context and scale matter in sustainability transitions, but there is little knowledge on how context and scale matter. In a literature review on the role of experiments in sustainability transitions, Sengers et al. conclude that the way in which experiments are embedded (or fail to become embedded) in local contexts such as cities and regions deserves further exploration. The authors raise the question how “proximities in local and regional networks, infrastructures, resource endowments, political agendas, market structures, cultural settings and so on influence the form and outcome of experimental initiatives?” (Sengers et al., 2016). Our research aims to address these gaps in our understanding and to take the next step in the integration of both research fields.

However, we are not aiming at a full integration of both theories. Rather, we attempt only to merge the factors from TM that explain the upscaling of sustainability experiments with the factors from RIS that explain the differences between regions in innovative activities.

2.2.4 The combined factors from TM and RIS

In Section 2.2.1−2.2.3 we discussed the theoretical background to our research. This is formed by complementary insights from the TM/SNM literature, the RIS literature and other literature on success factors. We are now able to combine these to construct two basic building blocks of our conceptual framework.

2.2.4.1 A longlist of success factors

The first building block of our conceptual framework is presented in Table 2.1. This is a longlist of success factors for sustainability experimentation. We have constructed seven groups of factors found in the literature. The success factors from TM/SNM literature and RIS literature have specific meanings. The factors from TM/SNM literature deal with factors that promote upscaling; in most cases this concerns upscaling from a technological niche towards a market niche (Geels and Schot, 2010). The factors from RIS literature deal with factors explaining the differences between regions in innovative activities.

The success factors from the TM literature are geographically implicit, and the RIS literature helps to make them geographically explicit. This combination results in 7 groups of factors, which are explained in detail below.

1. *Vision factors*. Kemp et al. (1998) mention the importance of creating a sectoral or societal long-term vision. This would help to coordinate the strategies of the stakeholders involved. Hansen and Coenen (2015) summarise a large number of studies emphasizing the important role of urban and regional visions. They also mention that local economic specialisations promote the innovations necessary for transitions. This specialisation is often the starting point for a regional policy agenda. We conclude that vision factors are expected to be mainly economically and geographically important on a local and regional scale.
2. *Network factors*. Kemp et al. (1998) state that new social networks need to be formed during niche formation. In addition, Boschma (2005) shows the importance of those networks as vehicles of knowledge creation and diffusion. In his work, various types of proximities are important. He shows that social networks are not necessarily localised. On the other hand, geographical proximity

brings people together and facilitates the exchange of tacit knowledge. These face-to-face interactions are also mentioned by Asheim and Gertler (2006). We conclude that network factors are expected to be important in various forms of proximity, and that a regional scale might be helpful especially for face-to-face interactions and for the exchange of tacit knowledge.

3. *Learning factors*. Kemp et al. (1998) mention that experiments should enact a broad learning process. In the RIS literature, the importance of learning is addressed in various ways. Asheim and Gertler (2006) combine two major features of the innovation process: the importance of tacit knowledge and the growing importance of a socially organised learning process. These features make apparent why the regional geography matters so much. In addition, the authors mention nongeographical learning factors. Other groups of the factors in Table 2.1 may also contribute to learning: e.g. network factors and demographic factors (esp. regional capabilities). We conclude that learning factors are expected to be important in various ways, often in a localised but also in a non-localised manner.
4. *Cultural factors.* In the sparse TM literature on cultural factors, there is a noteworthy study of the regional growth differentials in German photovoltaic markets (summarised in Truffer and Coenen, 2012). This study showed that the diffusion of photovoltaic energy in Germany was promoted by a local cooperative culture (although there were other factors at play, too). In the RIS literature, Asheim and Gertler (2006) emphasise trust-based relations in the cooperation between firms and customers in regional clusters. We conclude that cultural factors may be important, often on a regional scale, perhaps as an attribute of regional networks.
5. *Government factors.* Government factors are almost absent in both the TM and the RIS literature. Only few specific policy measures are mentioned. We conclude that government factors are unclear, and that they may be important on various geographical scales.
6. *Demographic factors.* These factors are not mentioned in the TM literature. In the RIS literature, Maskell and Malmberg (1999) discuss the regional capabilities for learning and innovation. In general innovation literature Rogers (2003) emphasises the importance of the attitude of users towards risks and the presence of innovators and early adopters for the diffusion of innovations.
7. *Other factors*. This is a mixture of factors mentioned by various researchers, see Table 2.1. We add to this that in general innovation literature von Hippel (1986) shows the importance of lead users. Lead users are familiar with future conditions, and may thus play an important role in the upscaling of sustainability experiments.

Table 2.1. Longlist of success factors from the TM and RIS literature.

Groups of factors for our research	Success factors from the TM/SNM literature	Factors from the RIS literature
Vision factors	Expectations & vision (Kemp et al., 1998)	Urban and regional visions, regional specialisation (Hansen & Coenen, 2015)
Local/regional network factors	Social networks (Kemp et al., 1998) Rootedness of networks (Dewald & Truffer, 2012)	Proximity between regional triple helix actors (Boschma 2005) Face to face interactions (Asheim & Gertler, 2006)
Learning factors	Learning (Kemp et al., 1998)	Knowledge spillovers (Van Oort & Bosma, 2012) Social learning (Asheim & Gertler, 2006) Skill base (Neffke et al., 2011)
Cultural factors	Cooperative culture (Truffer & Coenen, 2012)	Trust, informal institutions (Asheim & Gertler, 2006; Cortinovis et al. 2017)
Government factors	Room for experimentation (Loorbach, 2007)	Institutions, availability of funding, (Cooke et al., 1997)
Demographic factors		Regional capabilities, e.g. human resources (Maskell & Malmberg, 1999) Creative people (Florida, 2002)
Other factors	Competence (e.g. entrepreneurship) of the actors (Loorbach, 2007) The set-up of the experiment (Hoogma et al., 2002) Motivation of users (Seyfang & Smith, 2007)	.

We aggregated the factors found in the literature to 7 groups of factors, which are mentioned in the first column in Table 2.1. We used these factors directly in our empirical research.

2.2.4.2 A framework of experiments in distinctive favourite habitats

The second building block of our conceptual framework is presented in Fig. 2.2. We observe that a large variety of sustainability experiments have been carried out in Europe. These experiments differ in several aspects, including goals, themes, type of knowledge needed, actors involved, and geographical context. This is illustrated in the TM as well as the RIS literature. Sengers et al. (2016) describe six types of sustainability experiments. Tödtling and Trippl (2005) argue that there are different types of regions with distinctive preconditions for innovation. In order to answer our research question, we need to develop a conceptual framework that allows us to critically examine our hypothesis that there are various types of sustainability

experiments, and that they each have distinctive favourite habitats, each with specific success factors. We introduce the habitat concept here in order to suggest that an experiment is carried out in co-evolution with its geographical context. The habitat may promote or hamper the success of an experiment. An experiment is a member of an archetypical habitat, but regions and cities can host several types of habitats simultaneously. The dimensions in our conceptual framework should cover the large variety of experiments and success factors. We extract two main dimensions from the literature, which are presented in Fig. 2.2 as perpendicular to each other.

From the SNM literature, we hypothesise that there is a great contrast between experiments that are 'guided' (e.g. by visioning, see Kemp et al., 1998) and 'grassroots' experiments (Seyfang and Smith, 2007). This forms the vertical dimension of our framework. We call this dimension the governance axis, in line of the definition of governance by Bevir (2013), who uses governance in connection with governments, firms, networks and the grassroots movement (Bevir, 2013). *Guided experiments* show a clear governance, e.g. by an individual actor such as a firm or a government, and show a clear protocol for learning. There is no clear leadership in *grassroots experiments*. Their organisational form is diverse and may consist of voluntary associations, co-ops and informal community groups. They are often unstructured and do not leave formally documented institutional learning (Seyfang and Smith, 2007).

From the RIS literature, we hypothesise that experiments focused on technological innovation are different from experiments primarily focused on social innovation. This contrast forms the horizontal dimension of our framework. We call this dimension the knowledge axis because the knowledge involved varies widely.

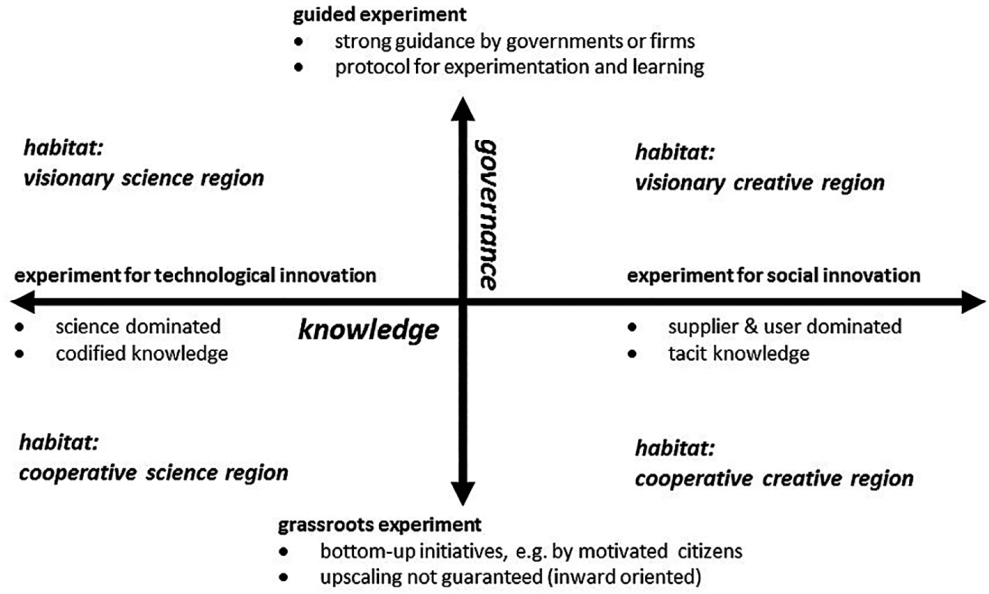

Fig. 2.2. Typology of sustainability experiments in their favourite habitats. We do not suggest that habitats are equal to regions. However, we hypothesise that habitats contain a configuration of success factors mainly on a local and regional scale.

Experiments for technological innovation deal with technological inventions. They are often science-dominated and use codified knowledge (Malerba, 2005). Codified knowledge may be easy to transfer to subsequent experiments. *Experiments for social innovation* deal with new ways of finding solutions for societal challenges; they also deal with behavioural change. They are often supplier-dominated and use tacit knowledge (Moulaert and Nussbaumer, 2005). Part of this knowledge may consist of symbolic knowledge, which is strongly tied to habits and norms of social groups (Asheim et al., 2007), and may thus be difficult to transfer to subsequent experiments.

We have now constructed a framework with four types of experiments. As indicated in Section 2.1, we suggest that experimentation is carried out in co-evolution with its habitat. We hypothesise that the habitat of an experiment may be regarded as a configuration of contextual factors which are mainly embedded locally or regionally. The various types of experiments each have their hypothesised favourite habitat. We found some indications of habitats in the literature. On the vertical axis of Fig. 2.2, Cooke (1992) discriminated ‘dirigiste’ regions (with high coordination and strong specialisation) from ‘grassroots’ regions (with low coordination and weak specialisation). On the horizontal axis, Spencer (2015) showed that neighbourhoods

with science-based innovations have different characteristics than neighbourhoods with creativity-based innovations. We hypothesise that these two habitat dimensions span four typical habitats, located in the quadrants of this conceptual framework (see Fig. 2.2).

We would like to emphasise that the two axes deal primarily with experiments rather than regions. To give an example: the habitat 'visionary science region' is hypothesised to be favourable to guided experiments for technological innovation. This kind of habitat may be found on and around a technologically-oriented campus. This habitat may for example be present in Silicon Valley. Here, the exchange of technological knowledge among firms constitutes a key element of the 'innovative milieu' that enhances innovation (Kenney, 2003). On the other hand, the habitat 'cooperative creative region' may be a very different milieu, and may perhaps be found around a city or region with many grassroots initiatives and a cooperative culture. For example, this habitat may be present in the village of Totnes, an 'alternative milieu' and a transition town in the South West of the UK (Longhurst, 2015).

It should also be noted that the ends of the axes are formed by two analytically distinct dimensions of 'governance' and 'knowledge'. The ends of an axis are not necessarily each other's opposites. Also, these dimensions have an analytical purpose. In reality, we expect to find many mixed characteristics.

We are now able to combine the two building blocks of our conceptual framework mentioned above. We hypothesise that the four habitats each contain their specific success factors. Each habitat may contain a specific subset of factors, selected from the longlist as presented in Table 2.1.

2.3 Material and methods

Our research question leads to examining the success factors, barriers and upscaling mechanisms of European sustainability experiments. Since we are one of the first to carry out an empirical study with such a broad scope in the field of the geography of transitions, we need a research design with an exploratory character. A qualitative research with semi-structured interviews (Bryman, 2012) is adequate for this purpose. Our research question contains two aspects, which both have distinct methodological consequences:

a. We wish to know whether there are important success factors that have not yet been mentioned in the literature. For this purpose we used open questions.
b. We wish to develop a more detailed understanding of the factors identified in the

literature. For this purpose we used semi-open questions.

Information was collected through telephone interviews, since we used open questions and since we wished to explain some concepts to the respondents. The main steps in our research were (i) formulating the research question and developing the questionnaire, (ii) selecting of the cases, (iii) interviewing and (iv) analysing the data to find the answers to the research question.

2.3.1 The questionnaire

The questionnaire contained the following elements:

a. Definition of success.
   In this research, our definition of success has two dimensions: a short-term and a long-term dimension (see Section 2.1). Our research question, however, focuses on the long-term dimension. In the questionnaire, we asked the respondents how they define success in their project. We asked this in an open question (we did not give any information about a short-term and long-term dimension in advance).
   We are interested in the success factors contributing to a long-term regime change, and therefore we asked the respondents to focus on these factors in the remainder of the interview.
b. The three most important success factors.
   Our survey has an exploratory character, which is why we asked respondents in an open question to indicate the three most important success factors.
c. Rating of habitat factors.
   We derived 6 groups of habitat factors from the literature (see Table 2.1). We asked for ratings of the habitat factors on a five-point scale.
d. Habitat factors in detail.
   In semi-open questions we asked respondents to suggest more detailed success factors for the 7 groups of factors mentioned in the first column of Table 2.1. We were also interested in the geographical scale of the success factors (from local to global).
e. Barriers.
   In an open question we asked the interviewees to indicate the three most important barriers.
f. Upscaling mechanisms.
   We asked for information on the links between the previous and the following

experiment in the upscaling trajectory. We also asked the interviewees to indicate activities in the project aimed at promoting future upscaling.

2.3.2 Case selection

At the time of data collection, numerous sustainability experiments were being carried out in Europe. To select relevant cases, our rationale was to incorporate the various types of experiments from our conceptual framework (see Fig. 2.2), various themes (agri-food, mobility and energy), in urban as well as rural areas in various EU countries. For the further case selection, we used three criteria:

a. The sustainability criterion. The experiment should be focused on the transformation of the way in which human needs are met (Sengers et al., 2016). In practice, we focused on experiments regarding energy (e.g. smart grids), mobility (e.g. sharing systems for electrical vehicles) and agri-food (e.g. regionalised food systems or urban farming); Fig. 2.4 presents some typical examples of sustainability experiments. Sustainability experiments are also goal-oriented; consequently, we were interested in selecting purposive interventions that explicitly seek to capture new forms of learning or experience (Castán Broto and Bulkeley, 2013).
b. The experimental criterion. The innovation should be in the experimentation phase of a transition (Rotmans et al., 2001). We translated this into a practical criterion: there should be a prototype available. This prototype might have been tested a few times, but there should still be uncertainty whether it will work in real life and whether it will be embedded in the regime. This criterion is also useful to make a distinction between experiments and the large group of sustainability initiatives.
c. The living lab criterion. We made this criterion more explicit. We asked the respondents to indicate if users are involved in the experiment, in a real-life of semi real-life setting.

All cases included in this study met these three criteria.

2.3.3 Interviewing

We interviewed people with sufficient knowledge of the experiment, of the actors involved and of the local and regional context. Often this was the project leader,

business manager or owner. We asked questions on success factors, barriers, upscaling trajectories and specific activities aimed at upscaling the experiment. The interviews lasted approximately 30 min.

2.3.4 Data analysis

All the data on success factors, barriers and upscaling mechanisms were coded manually. We carried out two analyses to find groups of respondents with a contrast in success factors:

a. We compared the guided experiments with the grassroots experiments, and the experiments aimed at technological innovation with the experiments aimed at social innovation
b. We compared the cornerstones of our framework: the success factors of experiments within the quadrants. In this analysis we did not incorporate the experiments that were a mixture of technological and social innovation (see Fig. 2.3).

The second analysis provided the strongest contrast (i.e. the differences in the factors mentioned were large). Each resulting quadrant has a small number of cases (see Fig. 2.3), varying between 6 and 14. Due to the low frequencies in the cells, it was not possible to evaluate these outcomes statistically with a chi-square test.

2.3.5 Description of the sample

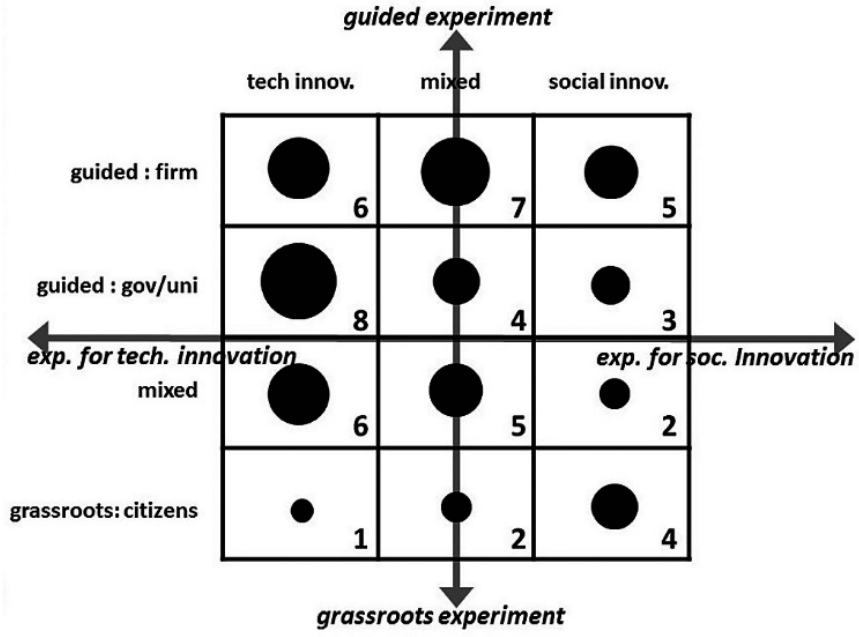

Fig. 2.3. Distribution of the research sample in our framework. The numbers represent the number of cases in our sample. Gov/uni stands for government or university.

Our sample was selected from all the sustainability experiments in Europe. The exact number of sustainability experiments in Europe is unknown. Castán Broto and Bulkeley (2013) found 159 climate change experiments in European cities. The European Network of Living Labs found approximately 400 labs in the past 9 years, but only some of these are related to sustainability. The grassroots initiatives in Europe are probably numerous, but these are difficult to find. About 400 grassroots food initiatives were found in the Italian province of Lombardy alone (Grasseni, 2014); some of these may be regarded as experiments.

Our sample contains 56 cases, distributed throughout 14 European countries (see Appendix 2.A). These cases were selected from existing European databases. We also used websites from the individual cases. Our sample contains the various types of experiments from our hypothetical framework (see Fig. 2.3), although there is an underrepresentation of the grassroots experiments (n=7), since it was difficult to find respondents for this group.

In our sample, 46% of the cases are involved in energy innovations, 38% in mobility innovations and 16% in food innovations. About 60% are located in urban areas, 20% in rural areas and 20% in both (some experiments were carried out in various locations).

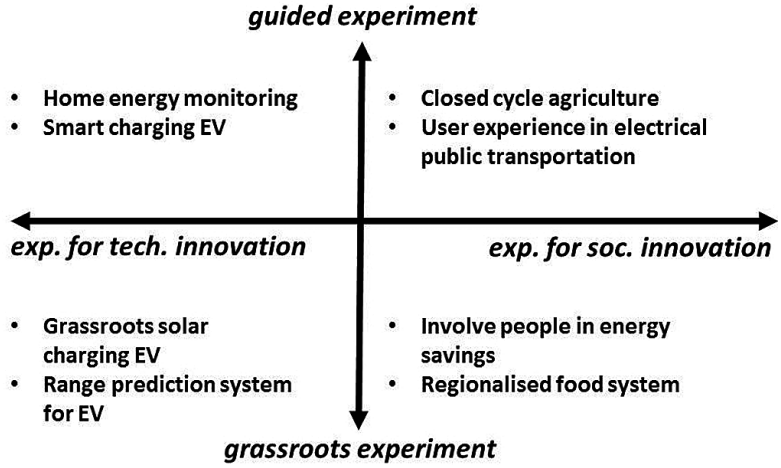

Fig. 2.4. Some typical examples of sustainability experiments in our sample. EV stands for electrical vehicles.

Fig. 2.4 presents some typical examples of our sample. The energy experiments often deal with smart grids, the mobility experiments deal with charging and sharing systems for electrical vehicles, and the agri-food experiments deal with regionalised food systems or urban farming.

In our sample we also collected experiments for social innovation. These experiments can be divided into two types. The first type involves technological prototypes, but the experiment is concerned with social or behavioural aspects, e.g. an experiment dealing with user experience in an electric public transportation system (see Fig. 2.4). The respondents often classified these kinds of experiments as a mixed form of technological and social innovations. The second type deals with prototypes of a new method or procedure, e.g. an experiment with a new method for involving people in energy savings (see Fig. 2.4).

2.4 Findings

Our research question is to find success factors, barriers and upscaling mechanisms

for sustainability experiments. Below we present our findings.

2.4.1 Success factors

2.4.1.1 Definition of success

In this research our definition of success has two dimensions: the short term and the long term (see Section 2.1). It is important to see how our respondents define success; Table 2.2 presents their ideas.

Table 2.2. The definition of success by respondents[2]. Indicated are the three answers mentioned most often, in % of the respondents. The respondents were allowed to include more than one definition in their answer.

Possibility for upscaling (48%)
Technical performance of the innovation (27%)
Usability (16%)

The respondents mentioned upscaling most (i.e. the long-term dimension of our definition of success, see Section 2.2.1). However, an interesting finding is that upscaling was often mentioned together with a different aspect, and particularly with technical performance. This relates to the short-term dimension of our definition of success. A lot of respondents had the opinion that the long-term and the short-term dimension of success are interlinked. Only 14% of the respondents mentioned profitability. This indicates that we are dealing with projects that are still in the take-off phase, and not yet in the breakthrough phase; after all, in the breakthrough phase the market introduction becomes more important (see Section 2.2.1). No large variations were found in the definition of success for the various types of experiments (see Fig. 2.2). This is remarkable, since it may be expected that upscaling is less important for grassroots experiments, as such experiments are often inward-oriented (De Moor, 2013).

2.4.1.2 The three most important success factors

User involvement was mentioned most frequently as the most important factor (Table 2.3). On the one hand, this is no surprise, as we are focusing on living labs. On the other hand, it is surprising, as this factor is almost absent in TM literature. Rotmans et al. (2001) mention the participation of actors in general. This may include

[2] All the findings in this section concern all the respondents in the sample (n = 54).

users, but he also points towards other actors (e.g. companies and governments). On average, user involvement was rated 3.9 on a five-point scale in our sample.
Interestingly, Table 2.3 shows a mixture of project-internal factors and habitat factors. Some factors may belong to both groups: learning involves learning from the user, i.e. a project-internal factor, but learning may also relate to social learning and dissemination, i.e. a habitat factor. Vision might have to do with a project vision, which is a project-internal factor, or with the existence of a regional vision, which is a habitat factor. However, our results show that a vision and learning are particularly important in the habitat.

Table 2.3. Success factors, classified as project-internal and habitat factors. Indicated are the answers mentioned most often, in % of respondents (open question).

Success factor	Project-internal or habitat
User involvement, esp. number of users, user experience, user engagement (33%).	Project-internal
Regional[3] network, esp. cooperation between partners (23%)	Habitat
Profitability, esp. business case, costs (21%)	Project-internal
Government, esp. funding by local/regional government, new regulation or absence of existing regulation by local/regional government (21%)	Habitat
Technical quality of the invention (19%)	Project-internal
Learning, esp. dissemination (16%)	Habitat
Vision, esp. a regional vision (10%)	Habitat

2.4.1.3 Importance of habitat factors

From the literature we derived 6 groups of habitat factors (see Table 2.1). Fig. 2.5 shows their rating. The four most important factors are also mentioned in Table 2.3. One factor is less important: the regional demographics. However, we have to be aware that some factors may be interrelated, e.g. culture and regional networks (see Section 2.2.4).

[3] In Sections 2.4 and 2.5, where the term 'regional' is used in combination with network, vision or context, this should be read as 'local and regional'.

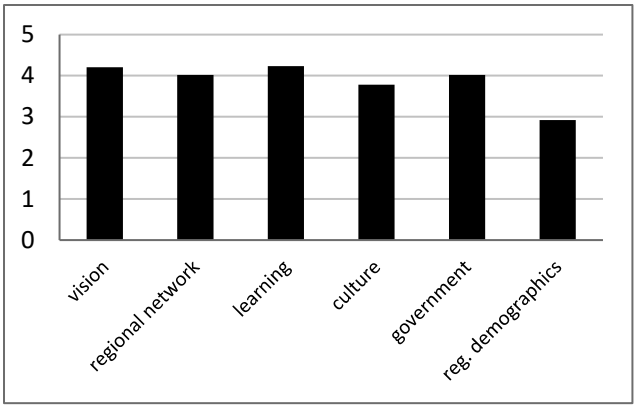

Fig. 2.5. The importance of habitat factors for success. Average rating by respondents on a five-point scale (semi-open questions).

2.4.1.4 Habitat factors in detail

We have searched for more detail in the six groups of habitat factors because this may provide the stakeholders with more relevant information about ways of improving the success of their experiments. The results show the following:

- In relation to vision, the availability of a regional vision is more important than a national or global vision.
- For regional networks, it is important that citizen groups and knowledge institutes are involved in these networks
- With regard to learning, important factors include (i) learning from the user by the team, (ii) social learning and (iii) second order learning.
- In relation to the local and regional government, funding is often mentioned as important. Moreover, the government can create an area with fewer regulations where experimentation is allowed. For new inventions entering society, the government can make new regulations.
- For cultural factors, the qualities trust, openness and cooperativeness are mentioned.
- With regard to the regional demographics, the regional knowledge and skills are mentioned.

2.4.1.5 Distinctive favourite habitats

Our hypothesis is that the various types of experiments have distinctive favourite habitats, each with their specific success factors. We found some indications for this variation between the types of experiments (Fig. 2.6).

These are the results of a semi-open question. For every group of factors (see Table 2.1), respondents were asked to indicate the most important one. This figure only displays the factors that were mentioned by 50% or more of the respondents for that habitat.

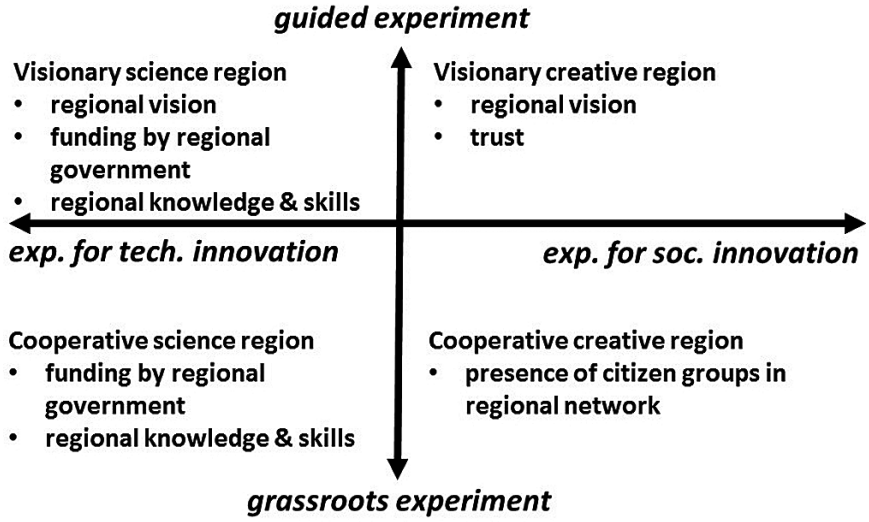

Fig. 2.6. Dominant success factors for distinctive habitats.

As shown in Fig. 2.6, we found some contrast in success factors between the quadrants. In particular, we found that some habitats are more pronounced in their visibility than others:

- The existence of a regional vision is mentioned in the upper quadrants. This directly relates to the habitats 'visionary science region' and 'visionary creative region'. A regional vision may give a strong guidance, and may form a habitat which is favourable for guided experiments
- The availability of funding is perceived as important in the 'visionary science region' and in the 'cooperative science region', i.e. in the habitats favourable for technological innovation. This success factor was also mentioned by Cooke et al. (1997), also in relation to technological innovations.
- The regional knowledge and skills are considered important in the quadrants on the left. This factor belongs to the group of regional demographic factors, and was not of eminent importance for the entire sample; however, it was important for experiments on technological innovation. Moreover, this factor is emphasised

in the mainstream RIS literature, which predominantly deals with technological innovations. Therefore, this finding supports our hypothesis.

- Trust is mentioned in the 'visionary creative region'. We hypothesised that trust is an important success factor, which is, however, not restricted to this specific habitat.
- The presence of citizen groups in the regional network is mentioned in the 'cooperative creative region'. It is not a surprise that the presence of citizen groups as such is mentioned, since we are dealing here with grassroots innovations. This refers directly to the literature on grassroots sustainability innovations, where experiments are carried out by citizen groups, e.g. co-ops and informal community groups (Seyfang and Smith, 2007). However, our findings suggest that these groups should be part of a regional network to become successful.

This contrast confirms our main hypothesis that the various types of experiments each have their distinctive favourite habitats, each with their specific success factors.

2.4.2 Barriers

We are also interested in barriers to success, mainly because these may be the opposite of success factors, and because they are relevant in the perspective of upscaling and regime change. The regime may pose barriers to the diffusion of niche innovations (Geels and Schot, 2010). Table 2.4 presents the most important barriers. Most of the barriers are the reverse of a success factor (the funding, the technical quality of the invention and regulations − or their absence). The third and fourth factors in this list indicate that the niches already meet some first regime barriers (see Section 2.2.1). The fourth factor mentions government regulation; note that this deals mainly with existing regulation as a barrier to experimentation.

Table 2.4. The most important barriers to success. Indicated are the answers mentioned most often (in % of respondents).

Shortage of money and funding (38%)
Insufficient technical quality of the invention (23%)
Resistance and vested interests (21%)
Government: existing regulation, absence of new regulation (20%)

2.4.3 Upscaling mechanisms

We have already indicated above that upscaling is a key challenge for sustainability experiments. Often, the experiments are part of an upscaling trajectory. In our questionnaire we explored this issue.
In our survey, we mapped the geographical upscaling trajectory (see Appendix 2.A). This trajectory is formed by the locations of the linked previous and the following experiments, and the links between these locations. Our results show that 71% of the sample are part of an upscaling trajectory. Two geographical patterns can be observed. The first deals with upscaling in the same location. This is sometimes called regional expansion (Jolly et al., 2012), and 50% of the experiments follow this pattern. The second pattern deals with upscaling somewhere else, either in the same

> *"To help upscaling, we made an evaluation of the project, to learn what went well and what went wrong" (quote from one of our respondents)*

region or in another global region. This is sometimes called replication or scaling out (Jolly et al., 2012). Our results show that 47% are replicated in another place in Europe. The map also indicates that replication distances are not very great: replication occurs mainly within a country or between adjacent countries. Only one experiment is replicated outside Europe.

To promote future upscaling, dedicated activities are carried out. Learning is important, as is shown by the quote above. Respondents often mentioned the following other activities aimed at upscaling: disseminating the 'lessons learned', networking, demonstrating and marketing.

2.5 Discussion

The main aim guiding this research was to find success factors, barriers and upscaling mechanisms of European sustainability experiments in their geographical context. The main finding is that the success factors are mostly embedded in the local and regional habitat.
We have two points for discussion: the usefulness of the habitat concept and the short-term versus long-term dimension of success. The first point for discussion is the usefulness of the habitat concept. We introduced the habitat concept to suggest that experimentation is carried out in co-evolution with its geographical context. We have identified three ways in which the habitat concept is useful.

First, the concept allows us to discriminate project-internal factors from contextual factors (see Table 2.3).
Second, as a result of this research we have found that a habitat could be regarded as a configuration of contextual factors that are mainly locally or regionally embedded. This relates to the factors 'vision', 'regional networks', 'government' and 'demographics'. These factors probably do not coincide geographically, but they are all localised mainly on the local and regional scale, as is shown in our empirical results. However, for some factors it is uncertain on which scale they are localised. This is the case for the cultural and the learning factors. These factors may also be important on higher scale levels. Also, the often mentioned factor "funding by local/regional government" may have its origin in European funds. With these results on factors and scales we address gaps in our understanding on the geography of transitions as indicated by Hansen and Coenen (2015). They raise the question how context and scale matter in sustainability transitions. We conclude that habitats do not have to coincide with regions, but they do have a strong regional focus. Furthermore, we suggest that habitats may overlap in a geographical sense. For example, various types of experiments may be carried out in one particular large city, each with their own distinctive favourite habitats.
Third, the usability of habitat concept would increase if we would be able to discriminate distinct favourite habitats for various types of experiments. We found some indications for this to be the case, but this was based on a small sample.
The second point for discussion is the short-term versus long-term dimension of success. We have included both dimensions in our definition of success (Section 2.1). Our findings suggest that these dimensions are probably interlinked (Section 2.4.1). In the transition literature is indicated that experiments that fail in the short term could still be qualified as successful in the long term, since they could contribute to global upscaling and regime change (see for instance Seyfang and Smith, 2007). However, our respondents did not indicate that success can be achieved by learning from failures. The only aspect of learning they mention is the importance of the dissemination of learning experiences (Table 2.3). This may be regarded as an important precondition for upscaling (Geels and Raven, 2006).

2.6 Conclusions

Our main conclusions are:

- The most important habitat factors are: regional networks, policy instruments of the local and regional government, the dissemination of learning experiences and

a regional vision.
- In addition to the habitat factors, we found that project-internal factors are also important for success, especially the factor 'user involvement'. This factor is mostly ignored thus far in transition studies.
- Shortage of money and funding is considered the most important barrier.
- Almost three quarters of the experiments are part of an upscaling trajectory, either in the same place or as a replication from experiments in different places in Europe.

With these results we address gaps in our understanding of the geography of transitions as indicated in Section 2.2.3. Our contribution to this emerging field (based on TM and RIS literature) is that we now have articulated how the geographical context and scale matters in sustainability experimentation. However, we are aware that our sample was small. For example, we lack respondents from southern and eastern Europe.
Our findings are consistent with previous findings in the TM and RIS literature, although some factors were found to be understated in the literature (e.g. the role of the local and regional government).
The findings of this research allow us to articulate some important policy implications:

- Habitat factors are important for the success of experiments. Policymakers should be aware that it is possible to enhance habitats, e.g. by creating regional networks. In these networks, entrepreneurs, users, civil servants from the local and regional government as well as other regional partners should work actively together to make sustainability experiments more successful.
- The local and regional government may play an important role in improving the habitat. For example, the government could create a location for experimentation in which there are fewer regulations. In addition, the government could draw up new regulations or fund experiments. Finally, the government often also contributes to developing a vision and regional networks. This important government role is absent in the current TM and RIS literature. Our finding may confirm that sustainability innovations require more nurturing in protective spaces than innovations in general (see Section 2.2.1).
- The introduction of professional practices for experimentation may greatly improve upscaling. These practices may for example deal with instruments and techniques to involve users, to disseminate learning experiences, and so on. Some attempts have been made to develop methodologies for sustainability experimentation, e.g. in the European Network of Living Labs, but still a large

number of experiments fail. In this research we hope to contribute to the development and implementation of more professional methods.

We found some indication that various experiments have their distinctive favourite habitats. However, more research is needed to understand how different habitats facilitate different types of experiments, and where to find these habitats in real life. Further research is also needed on the success factors and on possible ways to influence these. It is important to know which factors are essential, and which factors merely have a positive influence, as well as which factors can be influenced in the short term, which are relatively stable, and which may be self-reinforcing. We are greatly motivated to shine more light on this in future.

Acknowledgements

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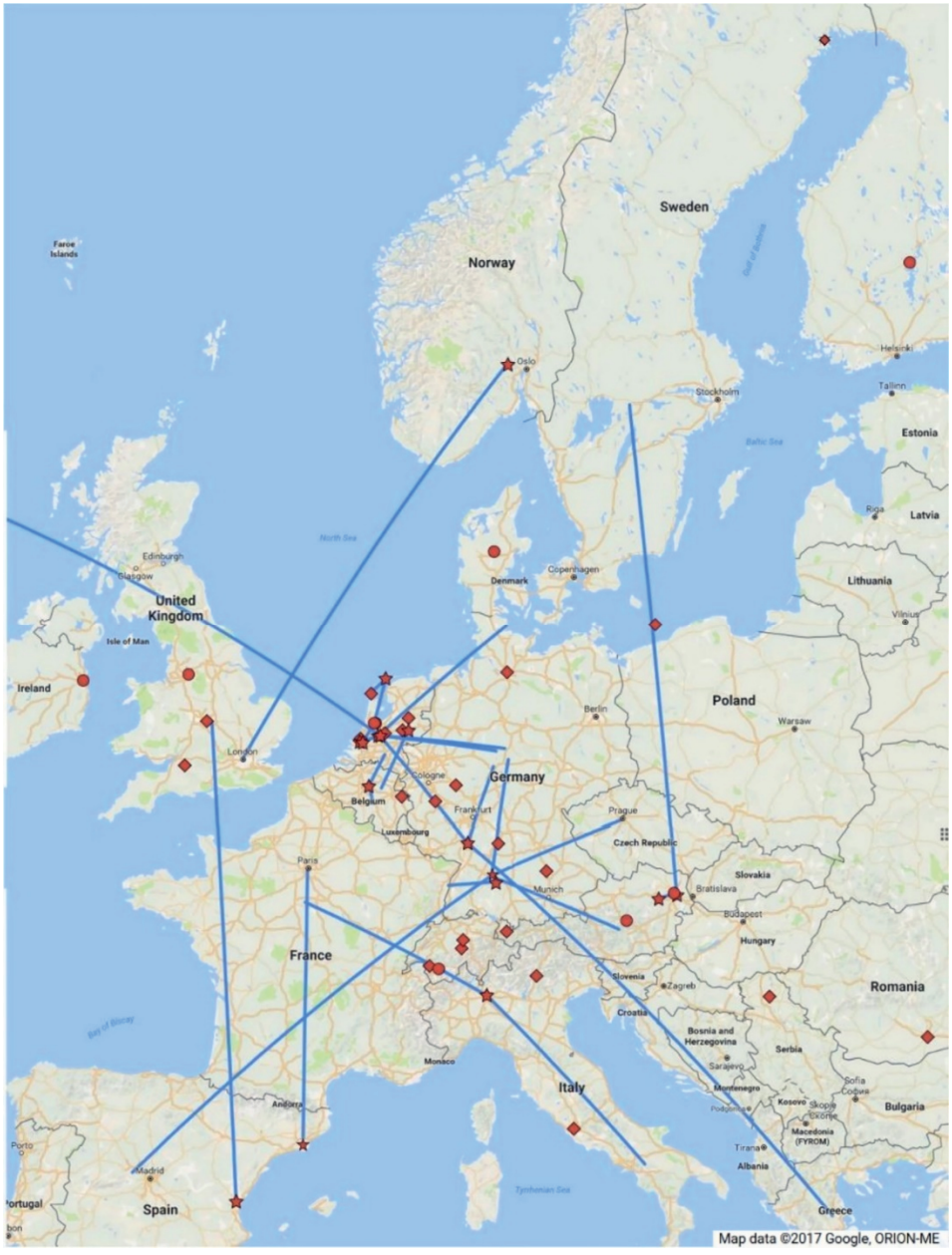
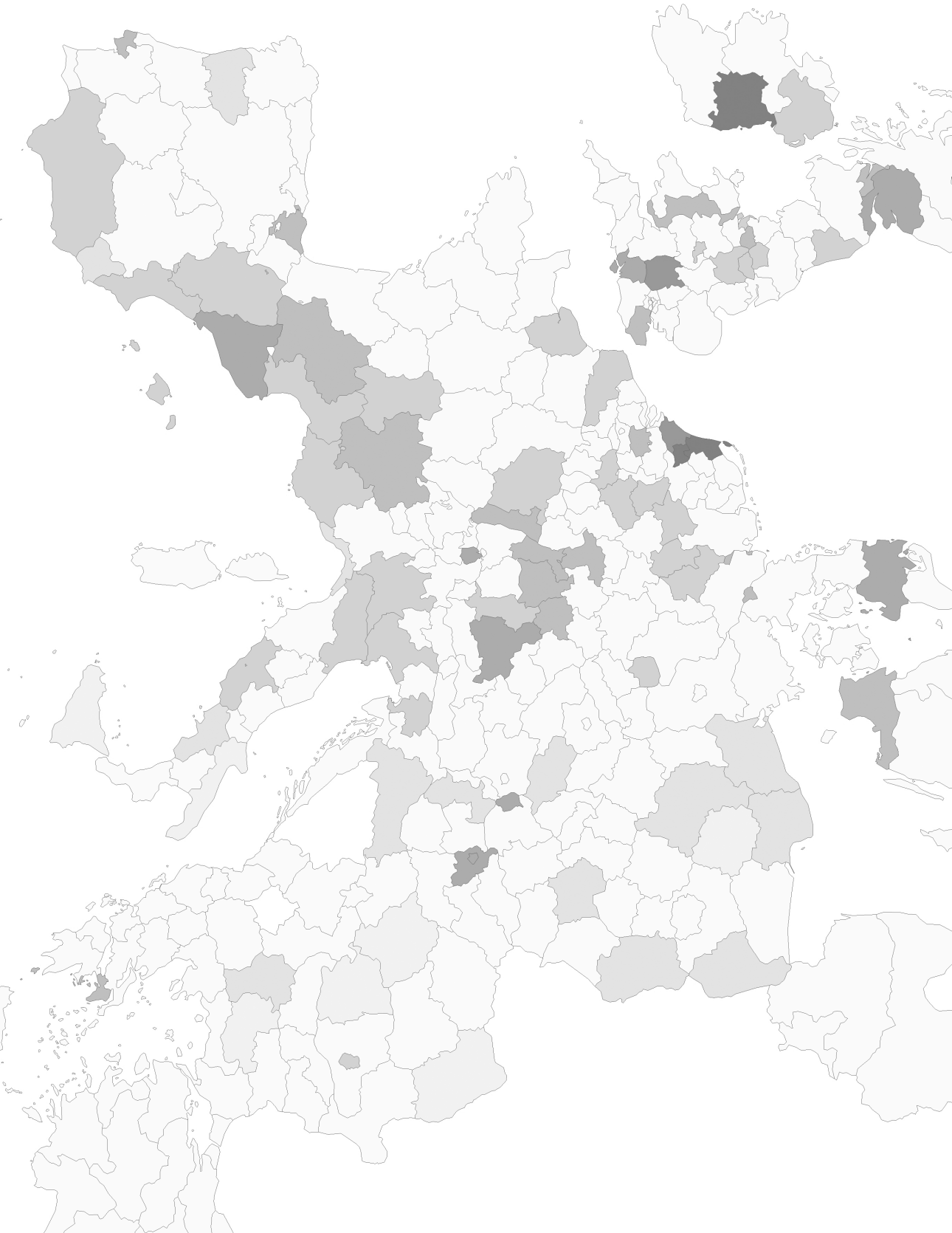
Appendix 2.A



The locations and the geographical upscaling trajectories of the experiments in our sample. The cubes indicate experiments without upscaling, and the circles indicate experiments with upscaling in the same location. The stars indicate experiments with upscaling to other locations (the lines represent the trajectories with previous as well as next experiments).



Chapter 3

Contrasting Regional Habitats for Urban Sustainability Experimentation in Europe

Abstract

The sustainability challenge requires experimentation with innovations, followed by an upscaling process towards a broader regime change in the long term. In Europe we observe various regional hotspots for sustainability experimentation which suggests that there are favorable spatial contexts. Little is known about why different kinds of experiments flourish or fail in various spatial contexts. In this Chapter we explore these contexts by using the habitat concept. A habitat is regarded as the configuration of favorable local and regional context factors for experimentation. To capture the diversity of these habitats we have constructed archetypical experimentation patterns. These patterns are built up of five dimensions: knowledge, governance, informal institutions, regional innovation advantages, and social learning. In a comparative case study in four city regions in Europe we find a large contrast in habitats. Countercultures play an important role, as they shape a beneficial context for experimentation through alternative ideas and lifestyles. We also find indications that it is important that a combination of several habitat factors is present, and that these factors have aligned and evolved over several years of experimentation, thus leading to a more mature habitat. The research suggests that regional stakeholders can positively influence most of the habitat factors shaping future upscaling. However, there are also some important factors, such as regional knowledge and skills, which have a path-dependent nature and are more difficult to improve in the short term.

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3.1 Introduction

Sustainable development is arguably the most important societal challenge of our time. This challenge requires several transitions. In the first phase of these transitions, an important activity is to experiment with sustainability innovations. A series of experiments may contribute to an upscaling process towards a broader regime change in the long term (Geels, 2002). It is important to consider the local and regional scale to learn what works and does not work in specific spatial contexts. Cities are seen increasingly as agents of change (Potjer and Hajer, 2018), as ideas spread more easily in densely populated areas because of proximity advantages. Moreover, cities increasingly see themselves as laboratories (i.e., experimental places) where innovations can be trialed (Evans, 2016). Experimentation is increasingly regarded as a governance strategy that may serve as an alternative to conventional predict-and-provide forms of urban planning (Bulkeley and Castán Broto, 2013).

While observing patterns of urban sustainability experimentation in Europe, researchers have identified particular regional hotspots for various types of sustainability experiments. For example, Berlin is well known for its grassroots food experiments (Wendler, 2016) and for its leading role in urban energy transitions (Monstadt, 2007), and Barcelona and Toulouse are known for their fab labs (Hielscher et al., 2015). It is relevant to ask ourselves why these localized densities of experiments exist (Longhurst, 2015), whether distinct regional contexts such as social or institutional factors make cities and regions favorable for experiments, and whether different local arrangements give rise to different patterns of experimentation (Raven et al., 2017).

More generally, these questions deal with the topic of how the spatial context matters in transitions. This topic is being studied in an emerging and exciting research field: the geography of transitions. Recently, the literature in this field has expanded considerably (Hansen and Coenen, 2015). We are interested in a specific phase of transitions, namely the phase of experimentation. As a contribution to this research field, we have recently developed the habitat concept (Van den Heiligenberg et al., 2017). The habitat is defined as the configuration of the most important spatial context factors enabling the future upscaling of sustainability experiments. We empirically found that these factors, such as the existence of a vision and of regional multi-actor networks, are deeply embedded, both locally and regionally.

The various types of sustainability experiments may flourish in specific habitats (Van den Heiligenberg et al,. 2017). For example, grassroots energy experiments may flourish in a transition town, and guided high-tech living labs may flourish in a science-based campus milieu. We are interested in capturing these contrasting

habitats and in the dimensions that cause this contrast; hence, our research question is the following: which spatial context factors enable the future upscaling of sustainability experiments in contrasting regional habitats in Europe, and can these factors be influenced in a positive way? It is important to clarify here that in this research we are interested in how to anticipate future upscaling of experiments during experimentation; we are not analyzing the actual upscaling process. This requires a predictive approach in our research design. We believe that a better understanding of contrasting habitats and upscaling factors would help to give the stakeholders involved in these experiments more tailor-made support for experimentation, including an improved understanding of how different contextual factors shape different patterns in experimentation.
The Chapter proceeds as follows. Section 3.2 provides relevant insights from the literature on the geography of experimentation and proposes an analytical framework. Section 3.3 specifies the methods used, Section 3.4 describes the findings in four cases, and Section 3.5 discusses and reflects on the results. Finally, in Section 3.6 a conclusion is presented and an agenda for future research is developed.

3.2 Previous Research and Conceptual Framework

3.2.1 Constituting Dimensions of Habitats

In this section we discuss analytical dimensions in spatial contexts from previous research. We primarily use the transitions literature and the literature on regional innovation systems. Various spatial context factors may enable sustainability experiments in their future upscaling. Although research suggests that experimentation is often embedded in multiscalar networks (Wieczorek et al., 2015), the factors that shape experimentation are mostly manifest at the local and regional scale and are entangled in path-dependent places. Hence, the landscape of experimentation is geographically uneven; in other words, the potential for experimentation varies across space (Hansen and Coenen, 2015; Heimeriks and Boschma, 2014).
The starting point for this research is the habitat concept. A habitat is defined as ‘the configuration of the most important spatial context factors enabling the future upscaling of sustainability experiments’. The habitat concept is related to several other concepts in the literature, such as fertile soil and the Territorial Innovation Model (TIM). (Fertile soil is understood to be a rich and diverse social texture for the emergence of new sustainability initiatives and the continuation of the existing ones.

However, this concept is limited to the context factors for grassroots experiments (Sekulaova et al., 2017). The habitat concept has a broader scope, and also includes guided experiments. A TIM is a model for regional innovation in which local institutional dynamics play a significant role. Several elements of a TIM have a path-dependent nature. TIMs and innovation ecosystems are focused on innovation for economic restructuring and enhanced competitiveness of regions. TIMs do not consider the noneconomic spheres of regional communities (Moulaert and Mehmood, 2010; Moulaert and Nussbaumer, 2005). The habitat concept has another scope; it is focused on innovations for sustainability, which have more difficulties in scaling up than do economic innovations (Van den Heiligenberg et al., 2017)]. When comparing TIMs and habitats, it is also important to note that habitats are not equal to regions. We suggest that habitats may overlap in a geographical sense (Van den Heiligenberg et al., 2017); for example, a large city may offer favourable spatial context factors for grassroots food experiments as well as for guided technological experiments.) However, the concept in essence is a further elaboration of the niche concept in the strategic niche management literature. In this literature, a niche is defined as a 'protective space' (Kemp et al., 1998). With the exception of a few notable contributions (e.g., Coenen et al., 2012; Fontes et al., 2016; Sengers et al., 2016), the geographical dimensions of the niche concept have not yet been made explicit. The habitat concept explicitly focuses on these geographical dimensions. In previous research we empirically found that experimentation is locally and regionally deeply embedded and we constructed a conceptual framework for a typology of experiments in favorable habitats; see Fig. 3.1 (Van den Heiligenberg et al., 2017).

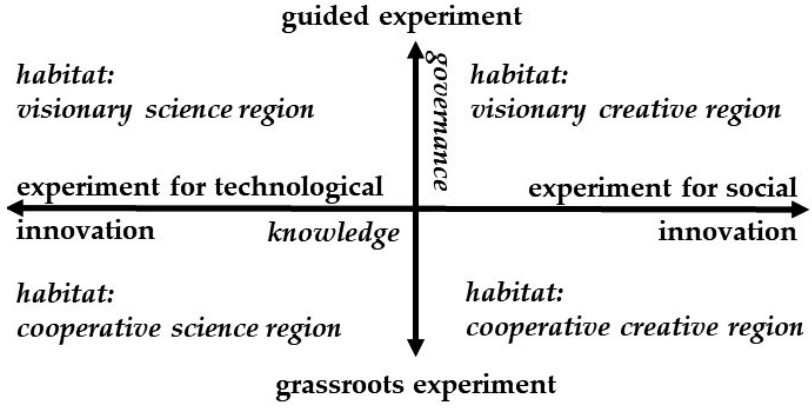

Fig. 3.1. Typology of sustainability experiments in favorable habitats. Adapted from Van den Heiligenberg et al., 2017.

To describe the various types of experiments, we made a distinction in two dimensions. First, for the governance dimension, we suggested that there is a contrast between ‘guided experiments’ and ‘grassroots experiments’. Second, for the knowledge dimension, we suggested that experiments for technological innovation are different from experiments primarily focused on social innovation. Using these two dimensions, four contrasting regional habitats have been constructed. We found that the following four generic spatial context factors for enabling future upscaling are most important: cooperation in local and regional networks, policy instruments from local and regional governments, dissemination of learning experiences and a local or regional vision of the future. However, we also found some first indications that there are distinct favorable spatial context factors for various types of experiments. These were the following:

- The existence of a local or regional vision is more important in the upper quadrants of Fig. 3.1.
- The availability of regional knowledge and skills is more important in the quadrants on the left-hand side.
- A cooperative culture is more important in the lower quadrants.
- Trust is more important in the quadrants on the right-hand side.

The aim of this study to systematically explore similarities and differences across the quadrants as described in earlier research (see Fig. 3.1). The main dimensions in the current research are thus formed by ‘type of governance’ and ‘type of knowledge’. As a second step, we add secondary dimensions by mobilizing additional insights from literature. These secondary dimensions are used to enrich the existing four quadrants. We remark that the dimensions are not distinctly geographical in nature; however, they are selected because the existing literature highlights these dimensions as localized, i.e., they vary across space, and at the same time they are relevant for sustainability experimentation. Thus, they might describe the uneven geographical landscape of context conditions for experimentation.

The literature provides three secondary dimensions describing the uneven landscape of spatial context conditions. First, in their literature review on the geography of transitions, Hansen and Coenen (2015) mention three themes which are related to experimentation: urban and regional visions and policies (relating to the habitat dimension ‘type of governance’), local technological and industrial specialization (relating to the habitat dimension ‘type of knowledge’), and ‘informal localized institutions’. Second, the regional innovation systems literature provides an additional dimension concerning ‘regional innovation advantages’. These

advantages have a broad scope (see Van den Heiligenberg et al., 2017 for an overview). Here, we focus on the localized capabilities enabling regional innovation. Third, we add a dimension concerning 'social learning'. Social learning is a key process in sustainability experimentation (Sengers et al., 2016). There are some indications that learning processes are localized (Maskell and Malmberg, 1999; Pekkarinen and Harmaakorpi, 2006); however, we believe that this localization requires further research. The resulting five dimensions are discussed below. We note that the discussion aims to contrast the four habitats, so as to clearly bring out their differences. As such, the discussion is an analytical simplification of, arguably, much more complex realities in actual regional habitats in the real world.

Type of Governance

This dimension deals with the geographical variation in context factors between guided and grassroots experiments. *Guided experiments* are coordinated by *governments or firms*. (In Section 3.2.1, the most important elements of the five dimensions are placed in italics. These elements will be used in the synthesis at the end of this section). These experiments are enabled by a clear regional vision or a strong economical specialization (Hansen and Coenen, 2015). A regional vision may function as a selection environment for experiments and development pathways (Hekkert et al., 2007) and as a tool to mobilize a group of actors (Essletzbichler, 2012). A strong economic specialization shapes the development of innovations necessary for sustainability transitions (Hansen and Coenen, 2015). Guided experiments flourish in a habitat or region with strong guidance from governments or firms (Cooke, 1992).

Grassroots experiments are emerging bottom-up, at least from the perspective of the local or regional government. They are *self-governed* by the civil society; they may consist of voluntary associations, cooperatives, and informal community groups. These experiments are often more loosely structured and do not always result in formally documented institutional learning. The learning is tacitly held within people, rather than consolidated in readily accessible forms. The small scale and the *geographical rootedness make scaling up difficult* (Seyfang and Smith, 2007). *Global platforms* of experiments, such as platforms for community-supported agriculture or fab labs stimulate the exchange of knowledge between experiments. However, some of these platforms struggle to define their form and purpose (Hielscher et al., 2015). These experiments may flourish in a habitat with low specialization (Cooke, 1992) and with a *cooperative culture* (Truffer and Coenen, 2012).

Type of Knowledge

This dimension relates to the geographical variation in knowledge conditions. Experiments for technological innovation produce mainly *codified knowledge* (Asheim et al., 2007). This knowledge is acquired mainly by *first-order learning*, i.e., learning which leaves fundamental notions, preferences, and values in society intact (Loeber et al., 2007). This codified knowledge might be easily disseminated by *'global pipelines'*, which create *openness* to the outside world, i.e., with selected providers outside the local milieu (Bathelt et al., 2004). These experiments may flourish in a habitat with science-based innovations (Spencer, 2015), in a region with a particular technological specialization.

Experiments for social innovation produce mainly *tacit knowledge*. This knowledge is acquired mainly by *second-order learning*, i.e., learning which may result in major changes in an actor's strategic choices, objectives, values, and preferences (Loeber et al., 2007). This tacit knowledge might be difficult to transfer between subsequent experiments in different regions (Asheim et al., 2007; Bathelt et al., 2004). These experiments may flourish in a habitat with creativity-based innovations (Spencer, 2015) in a region with a specialization in services.

Informal Localized Institutions

Localized institutions are defined as territorially bound norms, values, and practices; they have a major influence on the uneven spatial landscape of sustainability transitions (Hansen and Coenen, 2015). This unevenness occurs between regions and between localities, e.g., specific local cooperation cultures and attitudes towards knowledge sharing (Coenen et al., 2012). Related to informal territorial institutions is the concept of an alternative milieu. Longhurst (2015) illustrates how a localized concentration of countercultural practices, institutions, and networks may support sustainability experimentation. An alternative milieu may have a regional scale. Longhurst presents the following five forms of alternative milieus: radical politics, new social movements, alternative pathways, alternative spiritualities, and *alternative lifestyles*. In his case study on the village of Totnes, a so-called Transition Town, he shows that after almost a century of experimentation a localized milieu was formed, with a growing proliferation of alternative practices, institutions, and organizations (Longhurst, 2015). We can understand this formation as a process in which experiments and habitat co-evolve. Hielscher et al. (2015) add that such *countercultural movements* are often the birthplace of major advances in technology. These alternative milieus may offer a space for creating alternative ideas, practices, and social relations (Wittmayer and Loorbach, 2016), and are therefore highly relevant for transitions. An alternative milieu suggests strong connections with grassroots habitats (Hielscher et al., 2015), i.e., the lower quadrants of Fig. 3.1, but

it may be also relevant in other habitats.

Regional Innovation Advantages

Regions have distinct advantages for sustainability experimentation. The literature on regional innovation systems describes a wide variety of factors explaining the spatial clustering of innovation. These factors partly overlap with other dimensions described in this section, particularly with the 'type of knowledge' and the 'informal localized institutions' dimensions. Here, we focus on the economic specialization and the localized assets and capabilities enabling regional innovation.

Firms may profit from agglomeration economies, for example, regarding labor supply, generic infrastructure, and learning opportunities (Duranton and Puga, 2004). Green innovations are stimulated by factors such as a *pool of skilled labor*, supporting intermediary organizations, research institutes and universities (McCauley and Stephens, 2012), and localized assets and capabilities (e.g., infrastructure and institutions). The path-dependent nature and slow evolvement of such assets and capabilities make them difficult to imitate (Asheim and Gertler, 2006; Maskell and Malmberg, 1999).

Boschma (2005) mentions the advantages of institutional proximity for innovation. This includes the sharing of institutional rules of the game, habits, and cultural values. This proximity promotes knowledge transfer, interactive learning, and (thus) innovation.

Social Learning

Social learning is a necessary precondition for change towards sustainability (Loorbach, 2010), and it is a key process in sustainability experimentation (Sengers et al., 2016). Social learning deals with learning in groups, within a region as well as between regions. This dimension partly overlaps with the dimension 'type of knowledge'. For social learning we use the definition by Sol et al.: i.e., 'an interactive and dynamic process in a multi-actor setting where knowledge is exchanged and where actors learn by interaction and co-create new knowledge in ongoing interaction' (Sol et al., 2013). Social learning in a region is stimulated by *regional multi-actor networks*, and the diversity of actors involved enables a broad understanding of the issues at stake. The emergent properties of interaction in these networks are trust, commitment, and reframing (e.g., acquiring new insights and perceptions (Sol et al., 2013). The strong-tie relations within a region allow stakeholders to build trust and to exchange tacit knowledge. However, Boschma (2005) shows that *tightly coupled networks* run the risk of being locked-in (meaning that there is a lack of openness and flexibility) in specific exchange relations between network partners. As a possible solution for this lock-in, Boschma suggests creating

loosely coupled networks, which are *open* to knowledge from the outside world. Learning between regions is necessary, for example, for transferring experiments to other regions, and the dynamics may be different to those found for learning within a region. Various global networks of sustainability experiments, such as platforms for transition towns, fab labs, and community-supported agriculture, promote the exchange of codified knowledge and generalized (non-context-specific) frameworks (Geels and Deuten, 2006; Nicolosi and Feola, 2016). Some of these platforms struggle to define their form and purpose (Hielscher et al., 2015).
In this section, we concluded that the literature shows that different local and regional contexts may enable different types of sustainability experiments. These spatial contexts differ along a variety of dimensions, but the detailed factors and patterns as well as the differences across contexts need further exploration.

3.2.2 Synthesis: Archetypical Experimentation Patterns

In our conceptual framework we wish to capture the diversity of habitats in Europe, because this diversity has added value for transitions. These variations in cultures, institutions, political systems, networks, and capital stocks enable the promotion of, for example, new technologies, new lifestyles, and new policies (Truffer et al., 2015). Based on the current literature presented in Section 3.2.1, we construct archetypical experimentation patterns for the four habitats distinguished (Fig. 3.2). These archetypes describe the typical mechanisms of experimentation. They are built up of five dimensions: the knowledge used, the governance applied, the supportive informal localized institutions, the regional innovation advantages, and the social learning dynamics. We also propose an iconic example for each habitat. It should be noted that these archetypes are used for analytical purposes. In reality, we expect to find mixed forms.
First, the *Valley habitat* is inspired by the iconic case of Silicon Valley, where *technological innovations* have developed in a *science-based campus milieu*. Regional innovation literature emphasizes the *knowledge exchange among firms* as a key element in the innovativeness of this milieu (Kenney, 2003). Knowledge exchange is stimulated by a high rate of labor mobility. This mobility generates professional networks and the dissemination of new knowledge (Lam, 2005).
Second, the *Makerspace habitat* is inspired by the numerous fab cities worldwide such as Barcelona and Toulouse, where technological grassroots experimentation is carried out in various ‘makerspaces’; these are fab labs, hackerspaces, repair cafés, and so on. The ‘makers’ are often part of a radical countercultural movement, which includes *technological experts as well as creative people.* This movement is striving to become more self-sufficient, which is why an *open source and sharing*

culture is often promoted. A global platform supports knowledge exchange between fab labs worldwide (Hielscher et al., 2015).

Third, the *Middleground habitat* is presented as a favorable habitat for *guided experiments* for *social innovation* (although there may be other manifestations of this favorable habitat). The creative city is an iconic example. In a creative city, the middleground is a basic component of the local innovative milieu, where creatives (from the 'underground') and firms (from the 'upper-ground') meet and interact in creative processes (Cohendet et al., 2010). Florida (2002) demonstrates how a counterculture (the 'bohemians') in this milieu correlates with an underlying *openness to innovation* and creativity.

Finally, the *Do-it-ourselves habitat* is presented as the favorable habitat for *grassroots experiments and citizen initiatives* for social innovation. At the moment, grassroots movements are developing in cities worldwide, such as the Transition Town movement, but are often deeply locally embedded in particular places. A basic component of this habitat is a countercultural milieu, characterized by *alternative spiritualities and lifestyles* (Longhurst, 2015).

Fig. 3.2. Archetypical experimentation patterns in four habitats.

3.3 Methodology

Our research question requires a deep analysis of experimentation patterns and spatial context factors in a few contrasting regional habitats in Europe. A comparative qualitative case study (Flyvbjerg, 2006) is appropriate for this purpose. We wish to capture the diversity of habitats in Europe, to explore the dimensions that cause this contrast, and to find the diversity in factors that enable future upscaling. To this end, we selected four contrasting cases along the quadrants of our analytical framework. Each case consists of two elements, namely, a group of sustainability experiments and the corresponding habitat. For both elements, we selected a specific group of respondents: project leaders for the experiments and regional experts (i.e., experts who have an overall picture of the local and regional context of the experiments) for the habitat. A key issue in this research is how to anticipate future upscaling during experimentation. This was translated into interview questions about the actors' expectations of future upscaling. The main steps in our research were (i) case selection; (ii) data collection (developing the questionnaire, interviews, action-oriented workshop); and (iii) data analysis to find the answers to the research question (interview analysis, document analysis).

3.3.1 Case Selection

We looked for four cases that can be considered as paradigmatic examples (Flyvbjerg, 2006) of the archetypical experimentation patterns described in our conceptual framework (see Fig. 3.2). The archetypes are developed using existing scientific paradigms grounded in the regional innovation systems and the transitions literature. We have used these paradigms for describing four of these patterns. In a methodological sense we may consider these patterns as a first attempt to develop an explanatory typology (Elman, 2005). The empirical data of the comparative case analysis is then placed in the cells of this typology. Thus, we were able to compare the cases with the archetypes and give a first indication about the evidence and general applicability of these patterns (see Section 3.5).
The following three criteria were used for selecting the cases:

1. The cases were expected to show a sharp mutual contrast. We were looking for cases that match the archetypes, and as such were expected to differ considerably on the dimensions identified in the framework.
2. The cases were expected to differ from 'the mainstream' milieu. The innovative character of the experiments and habitat was an important criterion.

3. We did not want to select radical cases, such as Masdar City, Arcosanti, and Damanhur. These cases are sometimes isolated from their context and disconnected from existing systems, making them neither adaptable nor adoptable (Evans et al., 2016b; Fois, 2016).

We selected candidates for our cases from the literature, from sustainability conferences, and from websites. An additional practical criterion for selecting our cases was obtaining support from a regional expert who was willing to help us with the selection of the experiments and the respondents. Eventually, this selection process yielded four cases for this study, which were all located in a medium- or large-sized city, in European city regions.

3.3.2 Data Collection

Interviews
We developed interview questions for semistructured interviews with two groups of respondents, namely, the project leaders of experiments and regional experts. Some questions were similar for both groups, and some questions were specifically focused on one group. A detailed overview of the interview questions can be found in the appendix 3.A. For each case study, we interviewed 4–6 project leaders as well as 4–6 regional experts. We aimed to find the following regional experts for each case:

- a scientist in regional geography or economy;
- a regional policy advisor or politician;
- a local policy advisor or politician;
- a leader (or potential leader) of a local/regional sustainability network;
- an expert who has an overview of countercultures in the region.

The oral interviews lasted 60–90 min and were carried out by two researchers in 2016–2017. A detailed list of the 39 interviewees is presented in the appendix 3.A.

Action-Oriented Workshop
As we were aiming to conduct societally relevant research, we incorporated an action-oriented workshop in our research design. After finishing the interviews, we carried out a preliminary data analysis, and we then organized a group meeting with regional stakeholders (the interviewees and any other people willing to join). This meeting consisted of two parts. The first part was aimed at receiving feedback on

our analysis and at checking both the validity and the reliability of our preliminary data analysis. The second part was aimed at discussing what regional stakeholders could do with the results, and how they could influence the habitat in a positive way. Also discussed were the next steps to be taken towards possible joint activities of respondents and other stakeholders and towards building or strengthening a regional sustainability network. The group discussions were led by one of the authors of this article, acting as a professional sustainability facilitator to support the discussion with the regional stakeholders. A detailed list of workshops and participants can be found in the appendix 3.A.

3.3.3 Data Analysis

We analyzed the interview results (see Table 3.1) and carried out a document analysis, using scientific reports, policy documents, folders, websites, and project visits as an additional source (see Appendix 3.A).

Table 3.1. How the interview questions are related to the dimensions in the archetypical experimentation patterns (see Fig. 3.2 for the dimensions).

Dimension in Archetypical Experimentation Patterns	Related Interview Questions (the Letters Refer to the Questions as Described in the Appendix 3.A)
Type of knowledge	b. Experiments in the region c. Description of the experiment g Role of learning
Type of governance	b. Experiments in the region c. Description of the experiment
Informal localized institutions	a. Trends d. Factors expected to enable future upscaling
Regional innovation advantages	a. Trends h. Regional advantages
Social learning	g. Role of learning

Respondents made various statements, qualifications, and judgements, for example, about the living conditions in the region and about the presence of countercultures. The statements were validated using triangulation (i.e., by comparing these statements with statements from other respondents and with additional documents), using iterative research steps (i.e., by asking feedback on the preliminary interview results in the action-oriented workshop; see Section 3.3.2), and by reflecting with the colleague interviewer about the interpretation of the interview results.
Finally, we compared the four cases. An important element in this comparison was the question whether the cases indeed showed a mutual contrast (as expected on

the basis of case selection). We analyzed the diversity between the four city regions on two aspects: (i) the diversity in experimentation patterns and (ii) the diversity in the factors expected to enable future upscaling.

3.3.4 Description of the Cases

The four selected cases are presented in Fig. 3.3.

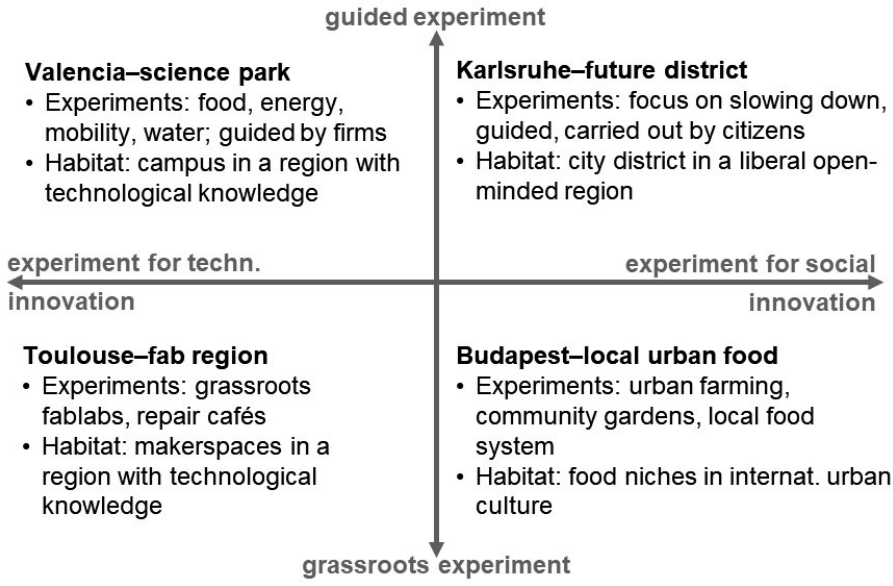

Fig. 3.3. Summary of the selected cases.

Below, we give short descriptions of the four cases, including the experiments we selected in these cases.

- **Case: Budapest—local urban food.** In the city of Budapest, a group of grassroots creative niche experiments were started recently, focusing on sustainable food supply. We analysed experiments with urban farming, community gardens, a local food system, a food bank, and a responsible gastronomy initiative. Some of these may have been inspired by examples from other countries in Europe, but there is also a historical link with widespread kitchen gardens in Hungary in the past. At the moment, 36% of the Hungarian population still owns a kitchen garden (Balázs et al., n.d.). The habitat in Budapest is special; it offers a number of supportive context factors, such as an urban culture and an international orientation. However, the grassroots

experiments may face serious growth challenges in a traditional and defensive regime context.

- **Case: Karlsruhe—future district.** In the Oststadt district of Karlsruhe, a group of living lab experiments are carried out, focusing on the good life in the future. The ambition behind these experiments is that "we need time to get re-acquainted to ourselves and others, time to reflect on our behaviour and the impacts of that" (Balázs et al., n.d.). The projects are focused on slowing down (i.e., to live in a more relaxed way) and community building. We analysed experiments with second-hand clothing, creative workshops, beekeeping, and district meetings aimed at reducing loneliness. The projects ran from July 2016 until March 2017 and were guided by the university and funded by the regional government. The habitat in Karlsruhe is interesting; in the past, many neighbourhood activities had been organized in this habitat, such as neighbourhood picnics. The regional context is formed by a prosperous region with a structural change towards science and innovation, and a growing creative class (Hammer et al., 2013). The region has a culture of liberality, open-mindedness, and willingness to experiment.
- **Case: Valencia—science park.** In Valencia, many sustainability experiments are carried out, often in a living lab setting. We analysed experiments with food (biological food in a hospital), energy (an ICT solution for saving energy), mobility (a sharing system for electrical cars), and water (water-saving technology). Experiments are governed by a hospital, a firm, the campus organization, and a technological R&D institute. The experiments are carried out in a campus milieu, often with strong links to the universities. The experiments are rooted in the technological specialization of the region, which has a culture of people willing to take risks.
- **Case Toulouse—fab region.** In the city region of Toulouse, there is a remarkable concentration of makerspaces. We analysed two repair cafés, two experiments in fab labs, and one in a hackerspace. The results of the experiments could be transferred to incubators and firms. There are about 25 incubators and accelerators in the region, many with a technological focus. The makerspaces have a strong community and the people involved have a general sustainability ambition, which is sometimes reflected in the experiments. The experiments are carried out by citizens. The regional conditions of Toulouse seem to be very well suited: there is a strong technological specialization in the region and a culture of open-mindedness.

3.4 Results

3.4.1 Budapest—Local Urban Food

In the Budapest region, many grassroots food initiatives have been started in the past few years, such as initiatives for regionalized food systems, urban farming, urban gardening, responsible gastronomy, and Food Banks. These initiatives are rooted in a deeper underlying food awareness, possibly in historical Hungarian gardening systems (Balázs et al., n.d.). In the last decade of the 20th century, many of the kitchen gardens disappeared; they were 'killed by the supermarkets' (interview no. 1.1). Since 2004, this food awareness has been growing in strength again, which can be observed in the growing interest of certain groups of citizens in sustainable food (healthy, organic, zero-waste, regional, solidary, and transparent). This increased food awareness and the new initiatives for regionalized food systems may be able to 'revitalize the historical kitchen garden system' (interview no. 1.4). Issues of trust and mistrust are often discussed. In the new localized food systems, people like to restore 'trust in the future, trust in clean and safe food, trust in the production system and trust in the farmer' (interview no. 1.10).

The *type of knowledge* involved in the habitat of the experiments analyzed varies from tacit (e.g., regarding the organizational aspects of a community gardens and a food bank project) to codified (e.g., in urban farming technologies). The habitat may contain localized knowledge about the historical Hungarian gardening systems.

The *type of governance* in the habitat of the projects is grassroots; the projects are carried out by citizens and by social entrepreneurs. There is no governance for these initiatives from the government. The political support for grassroots food initiatives was recently strongly reduced (interview no. 1.1). The people involved in the projects have not yet formed a network.

Regarding the *informal localized institutions*, we observe that one of the groups involved in sustainable food is a countercultural group of urban, young, open-minded, creative people 'with a lot of hope' (interview no. 1.1). The general feeling in this group is, 'yeah, I will be part of something, I will support the movement, the higher aims and values' (interview no. 1.3).

In our respondents' view, Budapest has some *regional innovation advantages* for regional expansion and the international replication of grassroots food experiments. Budapest is a Hungarian food hub, there is a large food awareness and an urban culture, and there are international influences such as from multinational companies (interview no. 1.7), foreigners, and tourists. These people can bring 'fresh views' (interview no. 1.2).

Social learning occurs and is needed at various levels. Respondents indicate that learning takes place on the level of individuals engaged in an initiative, on the level of the initiative, and between food initiatives in the region.
According to the interviewees, the most important *factors expected to enable future upscaling* of the initiatives are (i) the availability of funding; (ii) trust; (iii) recognized good examples; (iv) room for experimentation; and (v) a regional platform or network. Most of these factors are regional habitat factors. The interviewees indicate that it is possible to influence the factors in a positive way, stating that this improvement can often be achieved by the regional stakeholders themselves.
In *the final workshop*, possible next steps were discussed. The participants concluded that it is very important to create a sectoral platform or network where the people from various food-related initiatives can meet and exchange knowledge and ideas. Moreover, such a platform can foster the upscaling of different initiatives, and it can facilitate the development of hubs and training. The role of the platform is to engage partners, to execute experiments in pilot projects, and to develop regional, national, and international networks.

3.4.2 Karlsruhe—Future District

In the Karlsruhe region, many sustainability initiatives have been carried out, for instance, in urban gardening, fair trade, energy production, sharing, recycling, and repairing. The region has evolved from a 'civil servant' region (interview no. 2.7) into a region with science and innovation. In the Oststadt district, the creative class started to grow from around 2005 (interview no. 2.1); this may be related to the renovation of an old industrial area into a creative district.
The *type of knowledge* involved in the habitat of the selected projects is tacit knowledge, which is mostly related to organizational issues and ways to motivate citizens to join the initiatives: 'We learned a lot, especially how to organize such a project' (interview no. 2.5).
The *type of governance* is guided, with grassroots elements. Some guidance and support for these projects has been given by both the university and the government. Generally, there is strong political support for sustainability initiatives. The coordinator of the university supports the citizen groups by providing infrastructure, a meeting place, an existing network, public relations, funding, and legitimization. Within a set framework, the citizen groups are free to develop their initiative. The university forms a network with the various initiatives and creates a learning environment.
Regarding the *informal localized institutions*, the respondents indicate that the traditional values are still there, but a new counterculture is emerging. Elements of

this counterculture include community building, sharing goods, spending time with friends, social entrepreneurship, societal awareness, and an aversion to technology and ICT. 'Technological development is crazy; Internet, TV, …. This is not the way we would like to live. We would like to go back to personal contact' (interview no. 2.5). The counterculture is searching for a new lifestyle, but they are not considered radical: 'They are not rebellious, but they are innovative' (interview no. 2.7). This counterculture consists mostly of young, creative people, including artists and students.

The region offers various *regional innovation advantages* for these experiments. It is a prosperous region with high education levels and a high quality of life. The people are interested in living in a 'green public space' (interview no. 2.7). There is a supportive general regional culture; several respondents emphasize the mentality of the region (Baden-Württemberg, Germany). Elements of this culture include a liberal, open-minded, pragmatic, and solidary attitude, as well as a willingness to experiment.

Regarding *social learning*, several respondents indicate that learning is needed in every project. The involvement of the university generates learning between projects, for example, by organizing project evaluations and network discussions. Some important learning challenges include learning how to involve more participants in the projects and learning how to take more risk.

According to the interviewees, the most important *factors expected to enable future upscaling* of the initiatives are (i) room for experimentation; (ii) funding; (iii) regional networks; (iv) motivation; (v) political will; and (vi) leadership. These factors are a mix of project-internal and regional habitat factors. The interviewees indicated that the project-internal factors (such as motivation and perseverance) are often difficult to influence in a positive way. These factors are closely connected to individuals. However, the interviewees stated that the habitat factors can be influenced, mostly by regional stakeholders.

In *the final workshop*, the possible next steps were discussed. Many suggestions were made for future improvement of the habitat. The participants of the workshop discussed project-internal factors such as personal development (e.g., being tolerant, developing leadership, taking risks, and trusting that the projects will continue). The following suggestions were made for improving the habitat factors: making it more attractive to learn from projects, connecting with other projects in other groups in the city, and mobilizing more political support. In the group meeting there was a common opinion that it is important to develop more attractive projects, so that more people will be involved.

3.4.3 Valencia—Science Park

In the Valencia region, many technological sustainability experiments have been carried out, for instance, in food (e.g., biological agriculture), energy (e.g., ICT and technology), mobility (e.g., electrical vehicles), circular economy (e.g., plastics), and water (e.g., water savings). Since 1980, many technological institutes have been created to promote innovation. Agro-food is still a strong sector, and the energy, health, and creative sectors are emerging sectors. In 2015, a political change resulted in more support for sustainability.

The *type of knowledge* involved in the habitat of the selected projects is mainly highly specialized technological and codifiable knowledge originating from the universities and the R&D institutes, with a few tacit and social innovation elements (for example, in the behavioral aspects of an experiment with a sharing system for electrical cars).

The *type of governance* is guided. The experiments are governed by a hospital, a firm, the government, and a technological R&D institute. The city vision supports these experiments and promotes the execution of experiments in living labs. There are several regional sectoral networks.

Regarding the *informal localized institutions*, the interviewees state that the local/regional counterculture plays an important role in sustainability experimentation. It consists of groups of young people with a strong community feeling and an interest in social relations. Some respondents mention other characteristics (i.e., open-mindedness and willingness to take risks); others see these elements as a part of the general regional (or even Mediterranean) culture. The respondents do not consider the counterculture radical.

The interviewees indicate that the region offers a few *regional innovation advantages* for these experiments. One respondent indicates that ‘the living conditions, for instance the Mediterranean climate, are excellent. It is like California: this attracts innovators and talent’ (interview no. 3.1). The physical conditions for experimentation are good. The region has two universities and various technological R&D institutes. At the universities, the ‘international students bring new ideas and innovations’ (interview no. 3.5). Several respondents indicate that the region has an open-minded and entrepreneurial culture; people are not afraid of failure.

Regarding *social learning*, it is stated that ‘learning is everywhere’ (interview no. 3.3), both first- and second-order learning. Learning by doing is the favorite learning style. ‘Learning by doing is part of the Valencian mentality; we just try!’ (interview no. 3.4). For future upscaling to succeed, respondents indicate that it is necessary to exchange learning experiences with other projects.

According to the interviewees, the most important *factors expected to enable future upscaling* of the initiatives are (i) funding; (ii) vision and political will; (iii) socio-cultural

factors (community feeling, open-mindedness, willingness to take risks); (iv) entrepreneurship; (v) regional networks; and (vi) marketing. These factors are a mixture of project-internal and regional habitat factors. Respondents indicate that the project-internal factors (e.g., entrepreneurship) are difficult to influence in a positive way; these factors are closely connected to individuals. However, the interviewees indicate that the habitat factors can be influenced, often by the regional stakeholders themselves.

There was no interest in joining a *final workshop*, although in the interviews it was stated that 'collaboration in quadruple helix networks was important' (interview no. 3.1) and that there is a 'wish to exchange experiences in regional networks' (interview no. 3.7). It is not clear why the respondents were not interested in a workshop. We received feedback on our preliminary findings in a meeting with young regional experts in energy and climate change innovations. They also discussed additional ways to influence the habitat factors in a positive way, for example, by searching for additional funding sources, by branding Valencia as a living lab, and by stimulating curiosity in children to promote learning from experiments.

3.4.4 Toulouse—Fab Region

In the Toulouse region, many grassroots technological experiments have been carried out, for instance in approximately 35 fab labs, various repair cafés, a hackerspace, ICT associations, and electronics associations. The experiments are probably rooted in a long history of manufacturing industry in the region, and in a century of aeronautics industry. At the moment, the aeronautics and aerospace industries are a very important sector in the region. The region shows higher economic prosperity and employment growth than the average in France. The *type of knowledge* involved in the habitat of the selected projects is highly specialized technological codifiable knowledge, such as computer coding for a 3D printer or a laser cutter, in combination with creativity and design knowledge. This knowledge is widely available in the habitat. In the repair cafés, tacit knowledge is also involved.

The *type of governance* is grassroots. The habitat is characterized by self-governance by the 'makers'. However, the fab labs are a member of a regional federation and of a global platform. The global platform provides strict guidelines for the projects. The 'makers' want to be free to develop their innovations, without requirements or guidelines from funders. As one interviewee put it, 'we need a Maecenas!' (interview no. 4.8).

Regarding the *informal localized institutions*, respondents state that the region has a large countercultural movement. In the city alone, there are around 270 alternative associations. Important values of this group include being against overconsumption,

being self-sufficient, showing resistance, and employing guerrilla tactics. 'We put up resistance against … everything; this goes back centuries' (interview no. 4.10). The members of this movement meet at a yearly festival, which has about 35,000 visitors. Part of this movement is the fab lab community. The 'makers' appreciate this community, stating that 'the atmosphere here in the fab lab is helpful. It is about the community feeling, the creativity, the absence of competition and the commitment' (interview no. 4.5).

The region has various *regional innovation advantages* to offer for sustainability experiments; the Mediterranean climate is an important asset. The people show a strong social and environmental awareness. In addition, the region has a strong position in scientific engineering, in combination with creativity. This creativity is visible from the presence of artists and from an architectural and design school. A majority of the interviewees emphasize that there is a supportive general culture of open-mindedness, curiosity, and tolerance: 'Usually people say "not in my backyard". But in Toulouse the backyards are big!' (interview no. 4.8).

Regarding *social learning*, the interviewees state that a new way of learning has recently emerged, which is about sharing knowledge, learning by doing, and being allowed to make mistakes. The government has formulated an ambitious open innovation and open source strategy for the region. 'Toulouse wants to develop a model for the cooperative city in 2030' (interview no. 4.13). 'The region wants to be transparent. Everything should be open-source' (interview no. 4.10).

According to the interviewees, the most important *factors expected to enable future upscaling* of the initiatives are (i) the community feeling of the 'makers'; (ii) documentation and tools in the fab lab; (iii) regional networks; (iv) regional knowledge and skills; (v) funding; and (vi) communication. These factors are a mixture of project-internal and regional habitat factors. Respondents indicate that all the factors can be influenced in a positive way, often by the regional stakeholders.

In the *final workshop* it was concluded that the regional stakeholders (the makers, managers, coordinators, and politicians) do not yet have a coherent vision about the importance of fab labs for the makers themselves and for society at large. There is uncertainty whether fab labs are about having a good time while in the process of the 'making', or whether it is also about developing prototypes for the economic and sustainable development of the region and beyond. Important ingredients of a coherent vision about the fab labs might include the further development of a strong community feeling of sharing and collaboration, and the improvement in the conditions for transferring ideas and prototypes from the fab labs to elsewhere (i.e., other fab labs, incubators, and companies), for example, by keeping good documentation and by professionalizing the external communication.

3.4.5 Comparison of the Four City Regions

In Fig. 3.4, the four cases in the four city regions are compared regarding the five dimensions of the archetypical experimentation patterns. Fig. 3.5 shows a comparison of the factors expected to enable future upscaling.

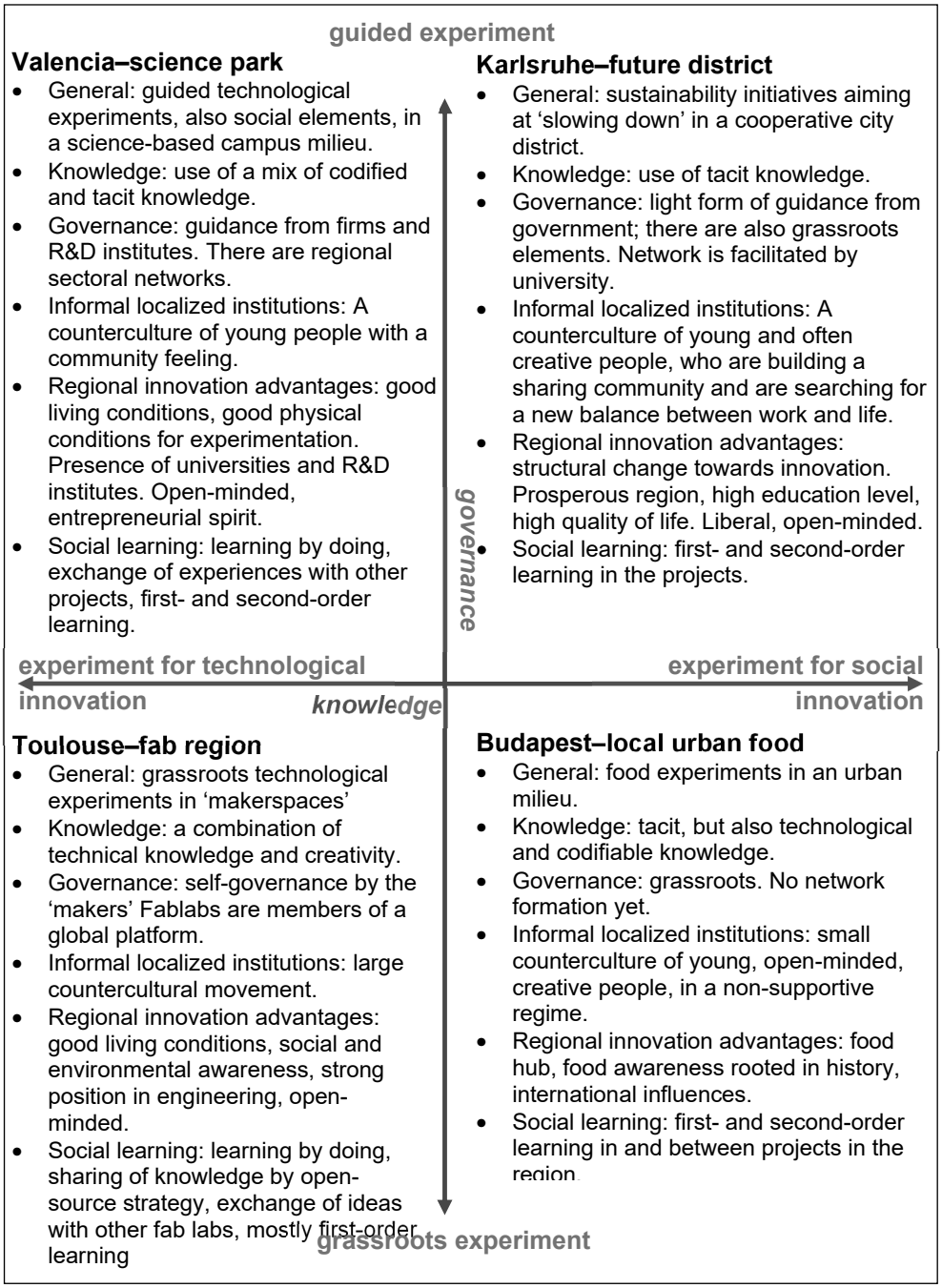

Fig. 3.4. A comparison of the experimentation patterns in the case study results. The framework is identical to the one in Fig. 3.2.

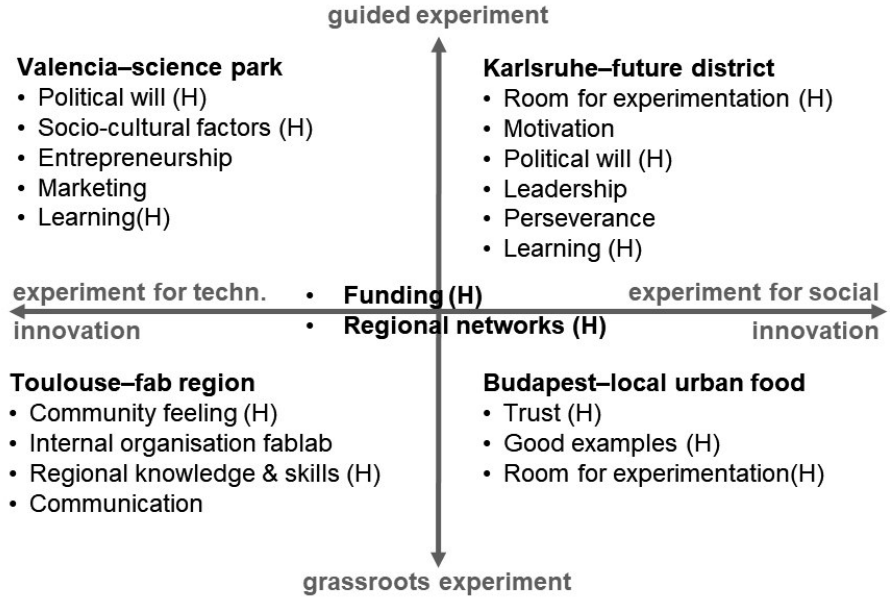

Fig. 3.5. Factors expected to enable future upscaling in the four cases. 'H' indicates that this factor is considered a habitat factor (The respondents gave additional information about the factors during the interviews. We used this information to distinguish habitat factors from project-internal factors). Factors mentioned by ≥30% of the respondents are presented here.

When comparing the experimentation patterns in the case study results, we find the following interesting similarities and differences:

- In general, we observe that the five analytical dimensions of the constructed archetypical experimentation patterns (see Fig. 3.2) have explanatory power for the diversity between the cases. However, elements of other archetypes are also visible in the cases. Such a mixture is, for instance, visible in the *Karlsruhe—future district* case (in which the governance is mainly guided but also has grassroots elements) and in the *Valencia—science park* case (which deals mainly with technological innovation but also has some elements of social innovation).
- The role of countercultures is worth noting; these are very important in all four cases. Apparently, they play a crucial role in experimentation and future scaling, for instance, as pioneer users, participants, or stakeholders. The importance of pioneer users of innovations has been described by Rogers (2003), who mentions the early adopters as an important user group and an integrated part of the local social system. In our research, the characteristics of the countercultures in the four cases are clearly different. In the upper quadrants, the countercultures

mostly comprise young people, for whom community building is important, and who are searching for a new lifestyle. In the lower quadrants, and especially in Toulouse, the counterculture has a more radical character; it shows a stronger resistance against the mainstream.

- In all the cases examined in this research, respondents emphasize creativity and open-mindedness as important cultural factors; creativity is not reserved for the 'middleground' habitat. This finding refers to the work of Florida (2002), who shows that creativity and openness to innovation correlates with a specific subculture. In a few cases, these factors are not limited to the counterculture but are rather a characteristic of the general regional culture. The regional innovation advantages are important in each of the cases. In three cases, the respondents underscore the good living conditions as important; in Valencia it was added that 'these conditions attract innovators and talent'. This was also recognized by Moulaert and Mehmood (2010), who mention the natural environment as an important part of an innovative milieu. There is a contrast in regional innovation advantages between the upper and lower quadrants. In the upper quadrants, the education levels and presence of knowledge institutes are emphasized, whereas in the lower quadrants, a social and environmental awareness is underlined. This awareness in the grassroots habitats is also emphasized by Seyfang and Smith (2007); they show that people's motivation for grassroots action is based upon different values from the mainstream, for example, by a bottom-up generation of alternative systems of provision.
- In every case there is a strong awareness that learning is an important factor in sustainability experimentation. Learning by doing is the favorite learning style in the two quadrants on the left-hand side. In the quadrants on the right-hand side, no favorite learning style was indicated. Overall, we see that stakeholders are primarily interested in exchanging knowledge, ideas, and experiences. This knowledge exchange can be classified as first-order learning. The interviewees do not mention second-order learning explicitly, although we observe some second-order learning in the quadrants on the right-hand side. Social learning was not directly addressed by the respondents; however, we observed a social learning process in the final workshops in the four cases. Indications of social learning were addressed in expressions such as "it is important to create a sectoral platform or network" (in the Budapest—local urban food case) and "it is important to develop more attractive projects" (in the Karlsruhe—future district case).

Fig. 3.5 presents a comparison between the factors expected to enable future upscaling. There is a wide variety of factors. We observe a mixture of project-internal

factors and habitat factors, as well as a substantial contrast between the four habitats.
In every case, the interviewees emphasize the habitat factors ‘funding’ and ‘regional networks’. For funding, it is indicated that it is necessary to have better access to public and private funds. For regional networks, there is a clear difference between the upper and the lower quadrants. In the upper quadrants, it is indicated that it is vital to build multi-actor networks with a shared vision. A tightly coupled network (Boschma, 2005) may promote the sharing of a vision. In the lower quadrants, the people involved in grassroots experiments are interested in being members of regional or global platforms. The links between members of these platforms are loose; they serve primarily for the exchange of knowledge between similar experiments.

3.5 Discussion

The main aim of this research was to explore the dimensions of contrasting regional habitats for sustainability experimentation in Europe. The main finding is that the five dimensions offer explanatory power for the diversity in factors expected to enable future upscaling. With the five dimensions we were able to construct four archetypical experimentation patterns. The empirical work has shown that the four cases belonging to these patterns each have specific factors expected to enable future upscaling.
The *first point for discussion* is a reflection on the ability to influence the habitat factors, i.e., the factors expected to enable future upscaling. From Fig. 3.5 it may be assumed that the ability to influence these factors is varied. Most of the factors, such as funding, room for experimentation, and regional networks, may be relatively easy to influence by the regional stakeholders (e.g., by the government) in the short term. This was also confirmed by the interviewees. However, some other factors, such as the regional knowledge and skills and the regional cultural factors may refer to localized assets and capabilities which are difficult to influence (Maskell and Malmberg, 1999). In the TIM literature, it is indicated that these elements depend on socio-economic and socio-political history (Moulaert and Nussbaumer, 2005). The respondents are more optimistic about this ability to influence these assets and capabilities than what is expressed in the existing literature.
The *second point for discussion* is the general applicability of the results. The findings of this research are based on four cases in four city regions in Europe. When comparing these findings with the developed archetypical experimentation patterns, we have two remarks. First, we observe that the analytical contrast between the

archetypes is less visible in the cases. The cases often represent mixed forms of the archetypes. With regard to the regional innovation advantages, we observe a large variety of factors mentioned in the cases. Some of them were included in the archetypes, but a lot of them are not, such as the living conditions. Second, we may conclude that each case is an example of a larger family of similar European habitats. We may even assume that other European habitats can be plotted in the analytical space that is spanned by the four cases. It would then be possible to find the factors for future upscaling for another habitat by interpolating between the four cases in this research. However, great caution is required here. This research has also made clear that regions may possess very distinct and unique dimensions of spatial context factors, which are of crucial importance to future upscaling. For example, there are regions with a pronounced economic specialization (such as the aeronautics industry in the Toulouse region) or regions with a defensive regime context towards certain sustainability experiments (such as the Budapest region). Furthermore, it should be noted that we have analyzed regions which contain a medium-sized or a large city; the situation in rural areas may well be very different.

The *third point for discussion* is the relationship between habitats and regions. In our earlier work we suggested that various habitats may overlap in a geographical sense (Van den Heiligenberg et al., 2017). In this research there were also some indications that a city region may host several habitats, and this may have important policy consequences. This research shows that regional stakeholders are able to influence the majority of habitat factors in a positive way. An important policy decision on a city level would, for instance, be the choice between promoting learning between firms and research institutes in a science park, or promoting community learning in a grassroots milieu. This research may help to make explicit decisions in such matters.

The *fourth point for discussion* is the importance of the maturity of the habitat. When we reflect on the habitat concept from a systems perspective, we could argue that it is not only important that the individual factors are present, but also that the factors are present in combination with one another and that the factors can mutually reinforce each other. The presence of these factors in combination can make the habitat more mature. Sekulova et al. (2017) indicate that the quality of the mutual relatedness of the factors (e.g., values, counterculture, a nonrestrictive regime) is relevant for creating a ‘fertile soil’ for grassroots initiatives. In fact, our findings show some indications regarding the maturity of the habitat. In *Budapest—local urban food* we observe a few motivated individuals experimenting with innovations, in a period with recent socio-political changes. There is food awareness, but common values are not yet explicit. The counterculture is very small, and a network has not yet been formed. There is no environment for learning between projects, and there is no supportive urban or regional vision. In *Karlsruhe—future district*, what we see is

different. We observe a large group of motivated citizens, a history of several years of grassroots initiatives in the district, common underlying values, participation by a countercultural group, an existing district network, an environment where learning between projects is stimulated, and supportive urban policies. We may therefore conclude that the habitat of *Karlsruhe—future district* is more mature than *Budapest—local urban food*, and that this maturity is the result of the combination of various habitat factors, including a history of several years of experimentation which may have improved the habitat in a co-evolutionary way. As one of the interviewees said, 'Karlsruhe has created a good habitat in the past years, and at the moment it is very good' (interview no. 2.4).

3.6 Conclusions

In this study, we had the following research questions: which spatial context factors enable the future upscaling of sustainability experiments in contrasting regional habitats in Europe, and is it possible to influence these factors in a positive way? The main conclusions are as follows:

- Funding and regional networks are important factors enabling future upscaling in every habitat.
- Every habitat has its additional distinct factors which enable future upscaling.
- This study suggests that it is possible to influence the majority of the habitat factors enabling future upscaling in a positive way, such as funding, room for experimentation, and regional networks. However, some important other factors, such as regional knowledge and skills have a path-dependent nature; as they are rooted in the socio-economic history of the region, they are not easy to improve in the short term.

In this study, we address gaps in our understanding of how different spatial contexts facilitate different types of sustainability experiments, or, in other words, how geography matters. We have developed four archetypes of these contexts and have identified distinct context factors. However, our analysis contains only four cases, with specific themes (urban food, slowing down, technological experiments on a campus, and makerspace experiments). It may be possible that other sustainability themes require different context factors.

Our findings are consistent with previous findings in the transitions and regional innovation literature, although some factors are found to be understated in the literature (e.g., the presence of a counterculture and the importance of regional living

conditions). We observe that the analytical contrast between the theoretical archetypes is less visible in the real world. Social learning is regarded as a key process in sustainability experimentation in the literature, and in practice we have observed that the respondents are aware of the importance of learning; however, they do not yet have an articulated opinion on the various forms of learning (e.g., first- versus second-order learning and social learning in groups) and the factors enabling learning. We have, however, observed social learning processes in the group meetings.
The findings of this research allow us to give some practical policy recommendations:

- We observe that nowadays policymakers are very interested in developing their own city or region into a copy of an iconic successful example, such as a 'Silicon Valley', a 'creative city', or a 'smart city'. This aspiration often goes hand in hand with a form of experimental governance to test innovations. This study has shown that there is a wide diversity in city regions. As a result, each city region may have its own specific context factors which enable these experiments. When making a future sustainability vision, we recommend for local and regional policymakers to anchor this vision in an analysis of the distinct available and necessary context factors. The method developed here may be useful for that analysis.
- An important finding of this research is that the majority of the habitat factors enabling future upscaling can be influenced in a positive way, mostly by the regional stakeholders. This insight may have empowered the group of interviewees and motivated them to think about future joint actions. Our policy recommendation is to support these discussions, and to stimulate the formation or further expansion of a multi-actor sustainability network or platform. These networks may enable experimentation towards future upscaling.

This study provides one of the first attempts to systematically analyze the spatial context factors enabling the future upscaling of sustainability experiments. We have found evidence that in experimentation processes, the geography matters. We are convinced that more research is needed, for instance, research including more case studies with different sustainability themes and different contexts, such as rural areas. It would also be valuable to analyze more cases with a defensive regime context, as these situations may require a specific approach. A second item for future research is the upscaling dimension. The four regions in this study not only have various context factors for experimentation, but also have different conditions for future upscaling. An important question for further research is which localized factors are needed for the actual diffusion and translation of sustainability experiments. We

recommend that this question be answered in future research.

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Appendix 3.A

Interview Questions, List of Interviewees, List of Workshops, Overview of Document Analysis

Interview Questions

We developed interview questions with two groups of respondents: project leaders of experiments and regional experts. Some questions were similar for both groups, and some questions were specifically focused on one group. This is indicated below. The following interview questions were asked:

a. Trends (experts only). We asked the interviewees to indicate the important demographical, economic, and cultural trends in the context of the sustainability experiments in this region. We incorporated the analysis of trends in the interviews, as experimentation in cities and regions may be strongly influenced by global or national pressures and social interests (Hodson et al., 2017) as part of the socio-technical landscapes in the multilevel perspective. Trends may result in change at the regime level, creating opportunities for experiments (Raven, 2005).
b. Experiments in the region (experts only). We asked the interviewees which sustainability experiments were carried out in the region.
c. Description of the experiment (project leaders only). We asked the interviewees what the experiment was about, what the respondent's task was, and what the respondent aimed to achieve with this experiment.
d. Factors expected to enable future upscaling (experts only). We asked the interviewees which factors were expected to enable future upscaling of the experiments in the region. Upscaling was translated into 'growth', to facilitate comprehension by the respondents. Some respondents asked for a clarification of this question. We explained that we define 'growth' as 'obtaining more users and more projects'.
e. Top five factors (project leaders only). We asked the interviewees to select the five most important factors that are expected to enable future upscaling for their project, and in what way these factors were important. Upscaling was translated into 'growth', to facilitate comprehension by the respondents. The respondents were asked to select the factors from a longlist of 15 factors.

   This longlist was built on our earlier research on habitats (Van den Heiligenberg et al., 2017). The longlist contained (i) the most important habitat factors from our earlier research (Van den Heiligenberg et al., 2017); (ii) the most important project-internal factors from our earlier research (Van den Heiligenberg et al.,

2017); (iii) social learning factors; (iv) two general factors; and (v) a 'wildcard' factor (chosen by the respondent).

Habitat factors were cooperation in regional networks, funding, room for experimentation, regional learning, match with regional vision/specialization, and regional knowledge and skills. *Project-internal factors* were user involvement, profitability, and technical quality of the innovation. *Social learning factors* were trust, commitment, and reframing (reframing was translated into 'gaining new insights and perceptions', to facilitate comprehension by the respondents). We used the social learning factors described by Sol et al. (2013).

We added two *general factors*: leadership and attitude towards risk. Leadership is often mentioned in both transition literature and entrepreneurship literature. The attitude towards risk is mentioned as a specific transformational leadership competence, focused on innovation (Senge et al., 2015).

f. Can the enabling factors be influenced (project leaders only)? We asked whether these factors can be influenced in a positive way, and if so, by whom.
g. Role of learning (both). We asked what the role of learning is in this process, e.g., is it needed to gain new insights.
h. Regional advantages (both). We asked what makes this region special for these experiments, and whether this region is unique for these kinds of experiments in Europe.

List of Interviewees

Case: Budapest—Local Urban Food

No.	Role and Type of Respondent	Date of Interview
1.1	Community gardens coordinator (project leader)	3 November 2016
1.2	Expert on food, abandoned spaces, and creativity (expert)	4 November 2016
1.3	Initiator of local food system (project leader)	4 November 2016
1.4	Expert in change agents in Hungary (expert)	4 November 2016
1.5	Responsible gastronomy volunteer (project leader)	6 November 2016
1.6	Foodbank project manager and trainer in agro-food (project leader)	7 November 2016
1.7	Urban farming pioneer (project leader)	7 November 2016
1.8	Local politician (expert)	8 November 2016
1.9	Agriculture researcher (expert)	9 November 2016
1.10	Local food systems researcher (expert)	10 November 2016

Case: Karlsruhe—Future District

No.	Role and Type of Respondent	Date of Interview
2.1	Team member of project on reducing loneliness (project leader)	13 January 2017
2.2	Initiator of project on second-hand clothing (project leader)	14 January 2017
2.3	Team member of project on beekeeping (project leader)	14 January 2017
2.4	Coordinator of local agenda 21/policy advisor of regional government (expert)	2 May 2017
2.5	Two initiators of project on creative workshops (project leader)	3 May 2017
2.6	Creative sector expert (expert)	3 May 2017
2.7	Three policy advisors of local government (expert)	3 May 2017
2.8	Coordinator of the future district projects (expert)	4 May 2017

Case: Valencia—Science Park

No.	Role and Type of Respondent	Date of Interview
3.1	Science park expert (expert)	11 May 2017
3.2	Team member of car sharing project (project leader)	11 May 2017
3.3	Business developer of ICT solutions for energy savings (project leader)	11 May 2017
3.4	Expert in international projects (expert)	11 May 2017
3.5	Expert in education for sustainability pioneers (expert)	15 May 2017
3.6	Two team members of biological food project (project leader)	16 May 2017
3.7	Two policy advisors of local government (expert)	17 May 2017
3.8	R&D manager in water savings technology (project leader)	18 May 2017

Case: Toulouse—Fab Region

No	Role and Type of Respondent	Date of Interview
4.1	Expert in makerspaces in Toulouse (expert)	30 October 2017
4.2	Fab lab manager (expert)	30 October 2017
4.3	Fab lab connector (expert)	30 October 2017
4.4	Researcher of regional economy in Toulouse (expert)	31 October 2017
4.5	Developer of creative prototype at fab lab (project leader)	31 October 2017
4.6	Advisor of repair café for bikes (project leader)	31 October 2017
4.7	Initiator of repair café (project leader)	31 October 2017
4.8	Developer of energy prototype at fab lab (project leader)	1 November 2017
4.9	Hackerspace developer (project leader)	1 November 2017
4.10	Former regional coordinator of fab labs (expert)	2 November 2017
4.11	Regional politician (expert)	2 November 2017
4.12	Fab lab coordinator and incubator (expert)	2 November 2017
4.13	Local politician (expert)	2 November 2017

List of Workshops

Case	Date	Location	Number of Participants
Budapest—local urban food	11 November 2016	Budapest	7
Karlsruhe—future district	5 May 2017	Karlsruhe	8
Valencia—science park	19 May 2017	Valencia	approx. 25
Toulouse—fab region	6 November 2017	Toulouse	10

Overview of Document Analysis

Case	# of Documents Analysed	# of Websites Visited	# of Folders Analysed	# of Visits to Meetings
Budapest—local urban food	2	3		1
Karlsruhe—future district	1	1	2	2
Valencia—science park	2	1		1
Toulouse—fab region	3	2		1

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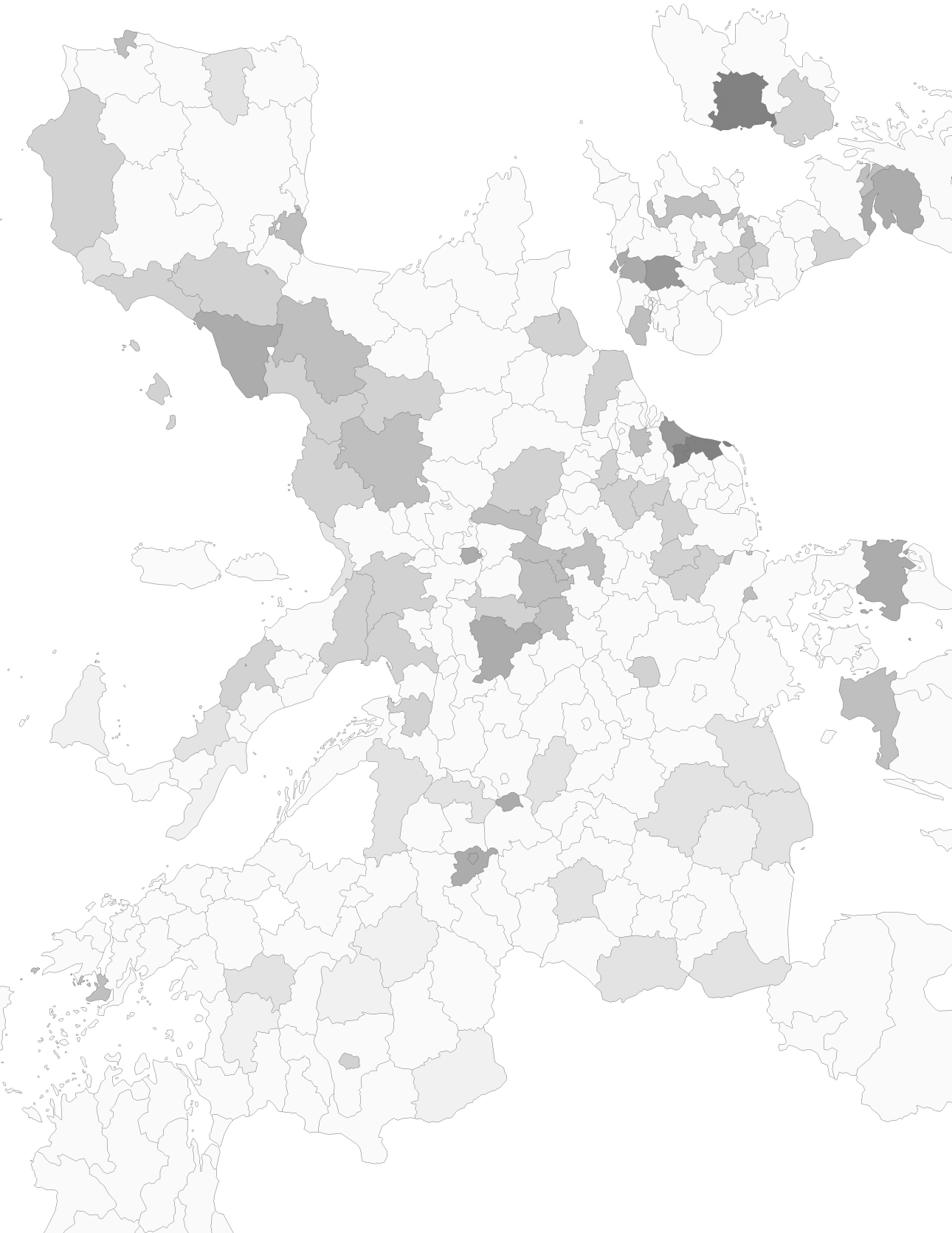

Chapter 4

Pathways and harbours for the translocal diffusion of sustainability innovations in Europe

Abstract

Sustainability challenges require experimenting with various types of sustainability innovations. Local and regional context conditions influence their diffusion. Our research question is: what are pathways for the transfer of sustainability innovations to other locations, and how do local and regional conditions enable this transfer? We use the notion of 'harbours' to conceptualise the combination of these conditions. In a comparative case study in four city-regions, analysing 48 experiments, we find that technological innovations travel easier around the globe compared to social innovations. For social innovations, the transferred knowledge has a more tacit character and the innovations are strongly embedded in the local cultural and institutional context. Signifiers may enable their translocal diffusion. Moreover, the results suggest that innovations are 'translated' rather than replicated. We find some important local and regional context conditions enabling transfer: cultural conditions, vibrant environments (such as festivals), networks and the presence of enabling regional actors.

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4.1 Introduction

Sustainability transitions require local experimenting and learning with various types of sustainability innovations. Transition theory has previously explored how these innovations emerge and diffuse, and how they may challenge existing regime structures towards a system change in the longer term (Geels and Raven, 2006). Diffusion is critical for sustainability transitions to take place and is supported through various mechanisms, such as scaling up, replication, circulation and institutionalisation (Turnheim et al., 2018). In this Chapter we are specifically interested in replication. Replication is often conceptualised as the repetition and the reproduction of an experiment in a new context, such as a new city or country (Turnheim et al., 2018). Currently, there is still limited understanding of this 'translocal diffusion'. The aim of our Chapter is to determine what mechanisms are involved in the transfer of innovations to other locations.

Previous research has demonstrated a spatially uneven pattern of experimentation (e.g. Binz et al., 2020). In Europe, city-regions such as Berlin and Barcelona are well-known hot spots (i.e. a localised high density) of sustainability experimentation (Van den Heiligenberg et al., 2018). However, city-regions in Europe also differ in the types of experiments and the processes through which these experiments emerge – ranging from experiments with social to technological innovations and from top-down to bottom-up governance approaches (Van den Heiligenberg et al., 2018). In the current Chapter, we extend this reasoning by exploring whether these hot spots differ not only in the conditions enabling experimentation, but also in the pathways enabling the translocal diffusion of these innovations.

A major challenge in the translocal diffusion of sustainability innovations is the fact that they emerge in the context of wider socio-technical systems which in turn are embedded in specific local and regional contexts. Previous research has demonstrated that it is not likely that they are directly transferable to different places (Raven et al., 2008). Due to these difficulties in translocal diffusion, we assume that it is seldom a copy-and-paste process. Although a technology may be copied to other locations, the diffusion of the whole solution (i.e. including for instance social or organisational elements) often requires a translation. Our main proposition is that this diffusion is easier when an innovation travels between similar locations, in other words locations with similar institutional, economic, political or cultural characteristics, because fewer translations and re-embeddings will then be required (Peck and Theodore, 2001). We argue that it is not so much the geographical travel distance (in km) but the similarity or dissimilarity in local and regional characteristics

between the sending and receiving locations that may enable or hamper this transfer, and this is in line with the proximity concept (Boschma, 2005).

To explore the conditions enabling translocal diffusion, we introduce the harbour concept. A harbour is defined as a combination of local and regional context conditions enabling the transfer of sustainability innovations to and from other locations. Various authors give examples that this combination of conditions is important for -the transfer of- innovations; it may concern physical aspects (such as a real harbour with the combined flows of goods, money, technology and people, see Blok & Tchötschel, 2016) and/or social aspects (the combination of a hub of connections, embedded in wider networks and circulations of resource, people and knowledge, and facilitating encounters, see Torrens, 2019). We conclude that in the literature there is not yet a clear picture of the combination that is relevant for the transfer of sustainability innovations.
Previous literature offers various insights into distinct context conditions. In *regional innovation systems* literature, a key mechanism for innovation is knowledge transfer, which is shaped by context conditions on a regional scale, such as openness (Boschma, 2005; Simmie, 2003). However, the regional innovation systems literature primarily focuses on innovations and their market potential; as such, this body of literature generally does not address questions of transition, i.e. how transfer of innovations may contribute to system change. Current *transition research* emphasises experimentation and the ways in which innovations scale up towards regime change, but only sparsely addresses the horizontal transfer and translation of innovations into new spatial contexts (Williams, 2017). One of the few articles on this topic addresses some general context conditions for translocal diffusion, such as socio-political or cultural factors and the skills of the actors involved (Loorbach et al., 2020); however, the article does not provide any details about these factors. Hence, there is a gap in our knowledge of the transfer pathways, and in the detailed local and regional context conditions enabling this transfer. Transfer pathways concern the mechanism by which innovations diffuse translocally, including possible differences in this mechanism for the things that actually travel (for instance a technology or knowledge). It includes also the relation with local embedding.

We address the following research question: What are typical pathways for the transfer of sustainability innovations to other locations and regions, and how do local and regional context conditions enable this transfer? To capture the diversity of innovations and contexts we will compare cases from various city-regions in Europe. In this study we mainly focus on the conditions enabling transfer in the context of the experiment. However, there are indications that the internal conditions of the project

may also play a role, such as the reputation and the skills of the actors involved (Loorbach et al., 2020; Torrens et al., 2019). We include project-internal conditions in this research to obtain an impression of their relative importance. In this study we will pay specific attention to the spatial scale of the context conditions. From the literature we learn that most of the conditions are present on the local and regional scales. In this study we will further analyse spatial scales.
Regarding the harbours, from the literature it is clear that a combination of local and regional context conditions is needed to facilitate the transfer of sustainability innovations, but it is not yet clear which combination this concerns. By being present together these conditions may also strengthen each other. This would be relevant information for local and regional stakeholders. In this research we will start to explore the relevance of identifying combinations of conditions enabling transfer, but with a limited number of case studies, we are not able to draw final conclusions on specific combinations of conditions.
The Chapter proceeds as follows. Section 4.2 presents our conceptual framework and provides relevant insights from various streams of the literature. Section 4.3 specifies the methods for finding answers to the research question. Section 4.4 describes the findings in four contrasting cases, and Section 4.5 discusses and reflects on the results. Finally, Section 4.6 presents our conclusions and provides some suggestions for future research.

4.2 Theory and conceptual framework

4.2.1 The building blocks of the conceptual framework

To develop a conceptual framework for the translocal diffusion of sustainability innovations, we will use both the *transition literature* as well as the *regional innovation systems literature*, because of their complementary character on the topic of translocal diffusion of sustainability innovations. In the *transition literature*, processes of experimentation and scaling-up are analysed. In the *geography of transitions literature*, the uneven spatial distribution of these experimentation processes are studied (Hansen and Coenen, 2015). However, this literature provides only little insight into the localised factors enabling this diffusion. Here, we use contributions from *regional innovation systems literature*, where knowledge transfer is studied as a key mechanism for diffusion.

Our conceptual framework has the following three building blocks: experiments, transfer pathways and harbours (see Fig. 4.1). For sustainability transitions to take

place, innovations are tested in various types of experiments. These innovations may be transferred to other locations and eventually challenge the existing regime structures towards a system change in the long term. Transfer pathways conceptualise the mechanism by which innovations diffuse translocally, including possible differences in this mechanism for the things that actually travel (for instance a technology or knowledge). It includes also the relation with local embedding. This transfer of sustainability innovations may be enabled by the combination of local and regional context conditions, which we term 'harbours' in this article. We will now explore the three building blocks of this framework in more detail.

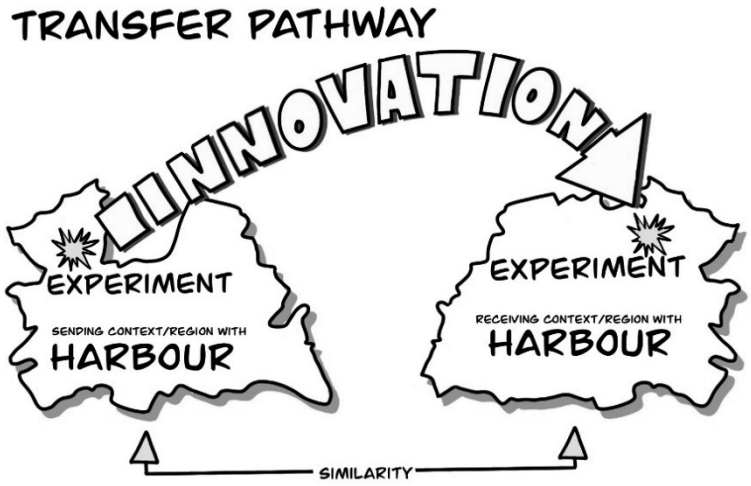

Fig. 4.1. Conceptual framework for the transfer of sustainability innovations.

4.2.2 Experiments

The first building block of our conceptual framework covers the various types of experiments (i.e. the activity) in which sustainability innovations (i.e. the novelties) are tested. Our proposition is that the difference between technological and social innovations is relevant here, since it relates to the different types of knowledge used in these experiments. Experiments for technological innovation produce mainly codified knowledge [Asheim et al., 2007]. 'Global pipelines' may enable a diffusion process, with providers outside the local milieu [Bathelt et al., 2004). Experiments for social innovation produce mainly tacit knowledge, the transfer of this knowledge to other regions may be problematic [Asheim et al., 2007, Bathelt et al., 2004). The

type of knowledge is relevant to this research because this may place additional requirements on the transfer pathway. This is further explained in Section 4.2.3.
We want to emphasize that this contrast between technological and social innovations has an analytical purpose. In real life we probably will meet many hybrid projects.

Another relevant dimension in types of experiments may be the distinction between top-down and bottom-up governance approaches. Van den Heiligenberg et al. (2017) suggest that guided experiments are government- or firm-initiated and grassroots experiments are civil-society- or community-initiated. Grassroots experiments may be often inward oriented, and less interested in upscaling.

4.2.3 Transfer pathways

Secondly, transfer pathways refer to the mechanism by which innovations diffuse translocally, including possible differences in this mechanism for the things that actually travel (for instance a technology or knowledge). It includes also the relation with local embedding. The mechanism of the transfer of innovations to other locations can be conceptualised in three steps: (i) a de-contextualisation, in which the context of the sending region is ‘removed’ from the innovation; (ii) the travelling of the ‘recipe’; and (iii) a re-contextualisation, in which the new context from the receiving region is added to the recipe (Williams, 2017; Turnheim et al., 2018). The form and function of the innovations thus changes as the innovations are translated and re-embedded in different institutional, economic, political and cultural contexts (Peck and Theodore, 2001; Williams, 2017). We use these conceptualisations to develop the conceptual model for this research. The model identifies objects (innovations and recipes) and transfer mechanisms, including a ‘fusion’ mechanism (see Fig. 4.2). The fusion mechanism refers to the combination of recipes from various innovations into a new innovation. Although the process of developing innovations by making novel combinations of product attributes is well known (Nelson and Winter, 1982), we did not find references to this fusion process in transition studies. Loorbach et al. (2020) describe a partnering process, which may be comparable to this fusion process. From the literature we may expect that for technological innovations who are “new for the region” (and not “new for the world”) this fusion process is frequently present. In this case also a “socio-technical template” will be available, which describes an acceptable way of using the innovation (Binz & Gong, 2021).

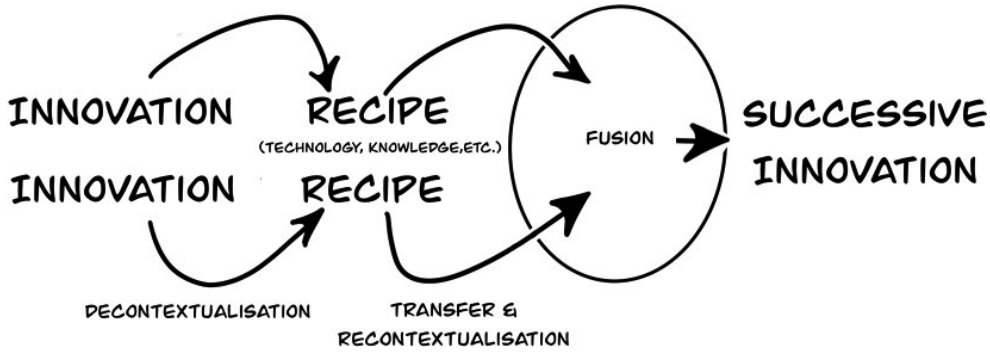

Fig. 4.2. The various elements of a transfer pathway

As visualised schematically in Fig. 4.2, a transfer pathway starts with an experiment with a sustainability **innovation**. The innovation is tested in a distinct location and is made context-specific by local embedding processes (Loorbach et al., 2020). This local embedding is key to the innovation's ability to be transferred to new spatial contexts (Williams, 2017). The **recipe** is the part of the innovation (as a result of a **de-contextualisation** process) that actually travels (Turnheim et al., 2018). We understand a recipe as the generalised form of the innovation, similar to the 'global form' concept (Williams, 2017). Some of these recipes relate to general (often global) concepts and have distinct names, such as 'community-supported agriculture' or 'repair café'. These names may act as 'signifiers', which are relevant to the transfer pathway because these signifiers make the recipes recognisable and findable for others who want to start a similar initiative (Loorbach et al., 2020; Silva et al., 2016). This transfer is further enabled by global platforms – for example a global repair café platform – where knowledge about these recipes is shared.

The recipe may have various forms; it may be knowledge, a technology, a tool, a norm or an idea (Wieczorek et al., 2015). Regarding knowledge, it is relevant to make a distinction between codified knowledge and tacit knowledge. Tacit knowledge, mostly related to social innovations, is strongly tied to the habits and norms of social groups and may therefore encounter more difficulties in its transfer than codified knowledge (Van den Heiligenberg et al., 2017). However, also technological innovations in certain sectors with a customised valuation system (where innovations are developed and tested in coproduction between producers and users) may show this local embedding in habits and norms (Binz and Truffer, 2016). We may thus suppose that social innovations (and technological innovations with a customised valuation system) need a stronger de-contextualization process for transfer. This will

result in a recipe with probably a more footloose character.

The various types of knowledge involved may also influence the transfer mechanism. The transfer of tacit knowledge may require temporary proximities, such as conferences and fairs, where face-to-face contacts are possible (Bathelt et al., 2004). In these transfers of knowledge, distinct actors may play a role (see Section 2.2.3 Harbours).

The transfer process may lead to a new experiment with a **successive innovation** in another location with other characteristics. We propose that a similarity in characteristics between the sending and the receiving region facilitates a successful translocal diffusion. We found some indications of this in the literature (McCann, 2016). Similar characteristics means that fewer translations and re-embeddings are required (Peck and Theodore, 2001). The similarity concept also has an analogy with the proximity concept in the regional innovation systems literature (Boschma, 2005). From this literature, we learn that the travelling of innovations over larger distances is not problematic in itself, but may become problematic when the sending and receiving regions are dissimilar.
It is important to emphasize that the similarity concept and the harbour concept are different. The similarity concept deals with similar general institutional, economic, political or cultural characteristics. These characteristics will probably differ from the context conditions enabling the transfer of sustainability innovations.

Finally, we note that Fig. 4.2 is a simplification of the transfer process in the real world. The transfer mechanism is probably not a linear process, but will show more bifurcations (senders sending knowledge to multiple receivers) and **fusions** (receivers receiving knowledge from multiple senders).

4.2.4 Harbours

The third building block in our conceptual framework is the harbour, which refers to the combination of local and regional context conditions that enable the transfer of sustainability innovations to and from other locations. In the model, we suggest that sending as well as receiving regions may have a harbour, i.e. a capacity to export or import innovations. The absence of -a combination of- local and regional context conditions may hamper this capacity. For the harbour concept we build on previous contributions on harbour and port concepts shaping the transfer of innovations, including Torrens et al. (2019), Ong (2011), Blok and Tschötschel (2016), Simmie

(2003), Boschma (2005) and Beck et al. (2013).4 Some authors explicitly refer to the importance of having a combination of context conditions enabling -the transfer of- innovations. Torrens (2019) refers to the combination of a hub of connections, embedded in wider networks and circulations of resource, people and knowledge, and facilitating encounters. Blok and Tchötschel (2016) mention a real harbour with the combined flows of goods, money, technology and people. Ong (2011) mentions the city as a particular nexus of situated and transnational ideas, institutions, actors, and practices that may be variously drawn together for solving particular problems.

Moreover, we executed a thorough review of the literature. We intentionally searched with a broad scope, to justify for the various bodies of literature and for the various concepts used in research on the transfer of innovations.[5]
We expect the following categories of local and regional context conditions to be particularly relevant.

[4] The harbour concept presented here resonates strongly with the literature review by Torrens and colleagues (Torrens et al., 2019). They present three metaphors for sustainability experimentation: the seedbeds, the harbours and the battlegrounds. They characterise the harbour metaphor as a space of exposure and encounter, offering a receptive context for ideas and facilitating the mobility of best practices. A theoretical foundation for the harbour concept is formed by the moorings/mobilities dialectic. Urry argues that “there can be no movement without context, without something to push off from” (Urry, 2003). The literature indicates that a harbour is often manifest on the scale of a city-region (Blok and Tschötschel, 2016; Simmie, 2003). A general assumption in the literature is that the diffusion of innovations is enabled by openness, meaning more access to the outside world (Boschma, 2005). In this research we use the harbour concept in a figurative sense, although also in a literal sense harbour cities may possess many of the conditions enabling transfer. In our view this has probably little to do with the function of an actual harbour from which innovations are shipped. Blok and Tschötschel (2016) show that harbour cities, because of their long-term international orientation, can be an assemblage point for local and transnational ideas. These cities may show a ‘cosmopolitan community’, potentially enabling collective action, cosmopolitical decision-making and international norm generation (Beck et al., 2013). We argue that the conditions enabling the transfer of innovations may also be available in cities and regions that do not host an actual harbour.

[5] We systematically searched for articles citing one or more early well-known key articles on the upscaling of sustainability experiments (in the transitions literature) and on the spatial diffusion of innovations (in the regional innovation systems literature). The key articles are: (Bulkeley and Castán Broto, 2013; Smith and Raven, 2012; Coenen et al. 2012; Bathelt et al. 2004; Maskell and Malmberg, 1999). This resulted in a list of over 1700 articles. From this list we selected empirical articles mentioning localised context conditions enabling replication, diffusion, upscaling or transfer of innovations, and we added a few important additional references to the technological innovation systems literature. The resulting list of about 30 articles was used for the Theory Section.

Local & regional cultural conditions

Cultural conditions cover the general values, norms and attitudes of actors; they may be localised on the local or regional scale. Institutional adaptations, such as a change in norms, values and beliefs, may stimulate diffusion (Van Waes et al., 2018). A general attitude of openness towards new ideas may enable the exchange of knowledge needed for translocal diffusion (Capdevila, 2018). Furthermore, the place-reputation is important for the adoption of knowledge and ideas by others (Sengers and Raven, 2015; Torrens et al., 2019).

Local & regional networks

Networks are broad and diverse social circles between related actors. In the innovation literature, they are considered important enablers of innovations and their diffusion (Powell and Grodal, 2009). In this way, networks are closely related to the transfer pathway (see Section 4.2.3.). In the regional innovation systems literature, it is emphasised that a firm's membership of a network facilitates the transfer of knowledge. Networks are relevant on the local as well as on the global[6] level (Trippl et al., 2009).

Local & regional vibrant environments

Vibrant environments may relate to greater diffusion success (Seyfang and Longhurst, 2016). In this study, we use such environments to indicate various forms of spaces and meeting places. These spaces and places enable interaction between actors, and they are conceptualised as temporary proximities such as conferences and fairs, also inspired by the 'local buzz' concept in regional innovation systems literature. Buzz refers to the information and communication ecology created by face-to-face contacts within the same place or region (Bathelt et al., 2004). These face-to-face contacts may be relevant for the transfer of innovations to other locations. Hubs, conceptualised as locations that have a high physical connectivity, such as airports, seaports and brainports, may relate to these vibrant environments and may enable a transfer of innovations (Conventz et al., 2014).

Local & regional enabling actors

Various actors in the regional context of the experiment may influence the transfer

[6] Regarding global networks, we are especially interested in the network membership by a regional actor, who may have a distinct role in transferring and translating knowledge from outside into the local and regional milieu, as described by Bathelt et al. (2004). Whether this membership is of a regional or global scale is debatable. Here, we consider the global network as having a global scale, and the membership of this network by a regional actor as having a local/regional scale.

of innovations in a positive way. This category is a broad category, encompassing various actors, actor groups and their activities. These actors include local and regional governments, universities and intermediaries, and they are involved in vision development, knowledge exchange and learning processes (e.g. by highlighting examples of good initiatives supported by for instance media attention), in funding and in creating a room for experimentation, enabling the (future) translocal diffusion of innovation (Kauffeld-Monz and Fritsch, 2013; Matschoss and Heiskanen, 2017; Van den Heiligenberg et al., 2017).

Table 4.1 presents a detailed overview of the local and regional context conditions found in the literature. This overview contains a large diversity of factors; we will empirically determine the most important ones.

Table 4.1. Detailed overview of local and regional context conditions found in the literature

category	local and regional context conditions
local & regional cultural conditions	• institutional adaptations (Van Waes et al., 2018) • culture of openness and an open-source mentality (Lawson and Lorenz, 1999; Capdevila, 2018; Van den Heiligenberg, 2018) • place-reputations (Sengers and Raven, 2015; Torrens et al., 2019) • reputation of local actors (Torrens et al., 2019)
local & regional networks	• interpersonal social networks (Huang et al., 2018b) • networks with users and producers (Lawson and Lorenz, 1999). • a firm's membership of a local/global network (Trippl et al., 2009). • regional networks and regional platforms (Noseleit, 2018) • membership of transition clubs and global city networks (Noseleit, 2018; Williams, 2017) • virtual knowledge communities (Trippl et al., 2009) • membership of global platforms (Capdevila, 2018)
local & regional vibrant environments	• temporary proximities, e.g. conferences, fairs, fair trade fairs (Bathelt et al., 2004; Feola and Butt, 2017). • geographical proximity of firms and clusters (Kaygalak and Reid, 2016) • geographical proximity of pioneers and followers (Huang et al., 2018a). • hubs, e.g. airports, seaports and brainports (Conventz et al., 2016). • knowledge hub (Ciapetti and Perulli, 2018).

Table 4.1. (continued)

category	local and regional context conditions
local & regional enabling actors	• global intelligence corps (Torrens et al., 2019; Williams, 2017), traders (Sjöholm, 1996), travelling bureaucrats (Torrens et al., 2019) and intermediaries such as consultants and employees of NGOs (Carvalho and Lazzerini, 2018; Inkinen and Suorsa, 2010; Matschoss and Heiskanen, 2017) • local and regional government by developing vision/policies (Schwanen, 2015), by enabling local and adaptive learning and networking (Giest, 2017; Karanasios and Parker, 2018; Andersson et al., 2018), by giving funding (Surana and Anadon, 2015; Schwanen, 2015), by realising institutional adaptations (Van Waes et al., 2018), by highlighting examples of good initiatives (Van den Heiligenberg et al., 2018) and by providing a room for experimentation (Van den Heiligenberg et al., 2017) • educated workforce and their spatial mobility enabling diffusion of knowledge (Bento and Fontes, 2015; Fitjar and Rodríguez-Pose, 2015; Miguélez and Moreno, 2013) • workforces engaging with informal networks enabling diffusion (Herstad and Ebersberger, 2015). • universities as gatekeepers enabling diffusion of knowledge (Kauffeld-Monz and Fritsch, 2013). • civil society, by transferring narratives (David and Schönborn, 2018). • leaders on the project level and movement level, e.g. by presenting their project to others (Boyer, 2018; Feola and Nunes, 2014). • Market formation by regional actors (Rohe, 2020)

4.3 Methodology

Our research question requires an analysis of the transfer pathways of sustainability innovations tested in experiments, and of the local and regional conditions enabling this transfer. For practical reasons we chose to focus on the enabling conditions on the sending side. Based on existing literature, we presume that these pathways vary considerably between the various types of experiments. For this reason, and in line with the explorative nature of the research topic, we chose for a comparative qualitative case study (Bryman, 2012). This allows us to analyse the contrast between various types of experiments regarding transfer pathways (for the local and regional context conditions we have only little indication from the literature that there is contrast between the various types of experiments). Building on earlier research (Van den Heiligenberg et al., 2018), we selected four city-regions in Europe to capture a diversity of experiments. New data were collected for this study to enable characterisation of the transfer pathways and the local and regional context conditions.

For each city-region, we selected appropriate projects and interviewed the project

leaders. Projects were selected based on the criterion that they were characteristic of the distinct type of activity for the case, as described in Fig. 4.3. A second criterion was that the projects should have an experimental character: i.e. a prototype is available, it may have been tested a few times, but there is still uncertainty whether it will work in real life and whether it will be embedded in the regime. A third selection criterion was that there should be evidence of attempts to bring the innovation to a successive experiment elsewhere, and this was verified in the interviews. We consider these experiments as 'sending' experiments, leading to successive experiments in another location. In the interview with the sender, we identified the 'receiving' experiment. To obtain a reliable picture of what had been transferred as well as to gain information about whether the innovation was actually used, we also conducted an interview with the project leader of the receiving experiment. The main steps in our research were (i) case selection, (ii) data collection (developing the questionnaire and executing the interviews), and (iii) data analysis to find the answers to the research question.

4.3.1 Case selection

As explained above, we used the cases from earlier research to cover a large variety of sustainability experiments. The cases show contrast along two dimensions: the type of knowledge used in the experiments and the type of governance in the experiments. Fig. 4.3 presents the four cases, which are four distinct types of experimentation in various city-regions in Europe.

Fig. 4.3. The selected cases (adapted from Van den Heiligenberg et al., 2017). The axes in the figure have an analytical purpose. In real life the experiments will show mixed characteristics.

4.3.2 Data collection

We developed interview questions for semi-structured interviews. The questions dealt with the innovation that was tested in the experiment, with what was transferred to a successive experiment and how this was transferred, with the location of the receiving experiment, and with the general and local/regional conditions that promoted this transfer. A detailed overview of the interview questions can be found in Appendix 4.A.

The interviews were conducted in two rounds. In the first round, in each of the four city-regions we interviewed the project leaders of six 'sending' sustainability experiments (a total of 24 interviews). In the interview with the senders, we asked them to identify a 'receiving' experiment. Subsequently, a second round of interviews was planned with the project leaders of the 24 receiving experiments. A detailed list of the interviews can be found in Appendix 4.A. Unfortunately, some of the interviews with the project leaders of receiving experiments could not take place. There were two reasons for this. First, in four cases we were unable to contact the receiver. Second, in three cases the sender was not willing to identify the receiver for reasons of confidentiality, in other words to protect the innovation or the partnership. This is also indicated in Appendix 4.A. The interviews were conducted by telephone and lasted 30-45 min; they were carried out by the researcher and an assistant in 2019–2020, based on a number of pilot interviews in 2017.

4.3.3 Data analysis

We analysed the interviews and reported the findings for each city-region along the three building blocks of our conceptual framework (see also Table 4.2):

- Experiments: a description of the type of innovation which was tested in the sending and receiving experiment.
- Transfer pathways: an analysis of (i) what was transferred (including a comparison of the statements about what was transferred between senders and receivers); (ii) the mechanisms of transfer (including how it was transferred, the use of recipes, as well as de-contextualisation and re-contextualisation processes, in relation to embedding and fusion processes), and (iii) the similarities between sending and receiving regions (including the spatial pattern of transfers to other locations). It was not possible to question the similarities directly; for this topic, we made a comparison of the sending and receiving region, interpreting statements from the interviewees.
- Localised context conditions enabling transfer and harbour: an analysis of the

local and regional context conditions that enable transfer, including an analysis whether they are enabling transfer in combination (harbour). The statements from the respondents in the interviews allowed us to analyse the spatial scale of the context conditions. Since we are also interested in the project-internal conditions (see Introduction section), we reported them separately.

The statements of the interviewees were validated by using triangulation, i.e. by comparing their statements with statements from other interviewees in the same city-region, by comparing the statements from sender and receiver, and by comparing with empirical findings from earlier research in these city-regions.

Table 4.2. How the interview questions are related to the dimensions in the case study findings.

Dimension in case study findings	Related interview questions (the letters refer to the questions as described in Appendix 4.A)	
Experiments	1a	Description of sending experiment
	2a	Description of receiving experiment
Transfer pathways	1b	Possibility of transfer
	1c	What was transferred and how
	1d	Location of successive experiment
	2b	What was received
Localised context conditions enabling transfer and harbour	1e	Conditions enabling transfer (sender)
	1f	Local/regional conditions for transfer
	2c	Conditions enabling transfer (receiver)

Finally, we compared the cases on the transfer pathways and the context conditions (including their combination in a harbour), also using the two propositions formulated in the Theory section: (i) *Experiments for social and technological innovation will have different transfer pathways* and (ii) *A similarity in characteristics in the sending and the receiving regions facilitates a successful translocal diffusion.*

4.4 Findings

4.4.1 Budapest – local urban food

Experiments

In the Budapest region, many grassroots food initiatives have been started in the past few years that focus on supplying sustainable food in an urban context. We analysed grassroots food experiments and initiatives as well as their transfer to other

locations. Five of the six 'sending' experiments covered mainly social innovations (see Table 4.3).

Transfer pathways

The experiments mostly transfer practical knowledge. The local food innovations and the practical knowledge involved are strongly embedded in the history of Hungary and in the widespread traditional 'kitchen garden' practice (Balasz et al., n.d.). This may hamper the translocal diffusion of innovations to other countries.

Table 4.3. Overview of the findings in the Budapest – local urban food case

sending experiment (all located in Budapest)	**receiving experiment and location**	**transfer pathway: what was transferred?**	**transfer pathway: how was it transferred?**	**localised context conditions**
green walls: indoor modular system for growing herbs and microweeds	vertical gardens (Budapest)	• practical experience • the reasons behind it*	• face-to-face meetings, workshops	• open-source mentality • international openness • trust and openness • local and national networks
responsible gastronomy: certificates for sustainable restaurants	sustainable cooking in restaurants (Budapest)	• practical knowledge; 'how to do it'*	• contact on network meeting	• shared sustainability ambition • open-source mentality • local network • educational attainment
local food system: buying food from organic farmers nearby and selling it in the city	local food shop: buying food from organic farmers nearby and selling it in the city (Budapest)	• part of solution • tool* • ideas • inspiration	• bilateral face-to-face contact • network meetings	• shared sustainability ambition • trust • openness • local network
food bank: taking food surpluses to poor people	food bank: taking food surpluses to poor people (Hajdú-Bihar, Hungary)	• complete solution • practical knowledge*	• bilateral face-to-face contact	• community in city • trust • friendliness • food network • food and transportation hub

Table 4.3. (continued)

sending experiment (all located in Budapest)	**receiving experiment and location**	**transfer pathway: what was transferred?**	**transfer pathway: how was it transferred?**	**localised context conditions**
community gardens: growing food with community groups	community garden: growing food with community groups (Budapest)	• practical knowledge	• bilateral face-to-face contact • contact on network meetings • internet	• shared sustainability ambition • openness and open-mindedness • subculture in district • festivals • support from government • support from university
food packaging; application of re-usable plastic cups on food festival	food packaging; application of re-usable plastic cups on event (Budapest)	• practical knowledge; 'how to do it' • the reasons behind it* • how to communicate*	• not mentioned	• shared sustainability ambition • vibrant environment • festivals • support from government • support from international NGO

* This information on what was transferred was mentioned by the sender or receiver only, and not confirmed by their counterpart.

Whereas the senders often showed a strongly idealistic sustainability ambition and a wish to transfer these ideals to others, the receivers sometimes had a more practical attitude; they were interested in the implementation of the innovations in daily practice. This implementation in daily practice may also signal an embedding process. In this transfer of mainly tacit knowledge, the geographical proximity between sender and receiver is important; knowledge transfer between sender and receiver is carried out via bilateral face-to-face contact and in network meetings in the city.

In three of the six Budapest sending experiments, a signifier was used (i.e. a distinct name concerning a general concept). One of these is the Community Supported Agriculture recipe; this is a global concept for a localised food system. Globally, this recipe is known as 'CSA', and in Hungary it has a distinct name (*Szatyor Bolt*) and distinct characteristics. This indicates a contextualisation to the Hungarian situation. A pioneer started this system in Budapest around 2007 and stated, "The name of our initiative is now used in other cities, on TV and at the Ministry. Our initiative was succeeded by 30-40 similar initiatives; however, the solution has not been copied"

[interview no. 1.5]. This again implies a de-contextualisation and re-contextualisation mechanism within Hungary. Only one sending experiment was transferred unaltered (replicated); this was a special case, where a food bank started a subsidiary in another city.

Five of the six analysed innovations travelled within the city of Budapest to a location with a similar cultural and political context as the sending location. Within the city, interviewees indicated that innovations travel even more easily within a specific district, to locations with a similar countercultural milieu and with similar political characteristics. As one interviewee stated, “Our district is supportive to the transfer of innovations. There is a strong community feeling, a progressive civil society and a vibrant environment. It is an enclave in a defensive regime context” [interview no. 1.11]. Travelling of innovations may thus be very much contained by these similarities.

Localised context conditions enabling transfer and harbour

The urban food counterculture in Budapest is a group of urban, open-minded and often young people. In the context of the experiments, the cultural conditions in Budapest are of key importance to enabling the transfer of innovations. Interviewees mostly indicated that these conditions (such as trust, openness and a sustainability ambition) are localised within the food subculture in the city, or even within a particular district [interviews nos. 1.1, 1.2, 1.3, 1.8 and 1.10]. This subculture has strong shared values regarding sustainable food, such as food should be healthy, zero-waste and solidary (Van den Heiligenberg et al., 2018). Three interviewees mentioned that the transfer of knowledge takes place in vibrant environments such as festivals, where the subculture meets. Local food networks support this transfer.

Budapest has a distinct food and transportation hub function in the country. This is a condition especially important for the food banks, since they are reliant on food flows. It is unclear whether this hub function also influences the transfer of innovations.

Half (50%) of the interviewees identified the skills of the people as a condition that enables transfer. We asked in more detail to what extent these skills were necessary. Since these skills were identified as related to the senders and receivers rather than to the general environment, we do not classify these skills as a context factor, but as a project-internal factor.

4.4.2 Karlsruhe – future district

Experiments
In the Karlsruhe region, many small-scale sustainability experiments are carried out, organised by social entrepreneurs or citizens, with some guidance and support from the government and the university. We analysed experiments and initiatives from this group of experiments, including their transfer to other locations; they cover mainly social innovations and use not only tacit but also codifiable knowledge (see Table 4.4).

Karlsruhe is a city-region in which many new sustainability initiatives and experiments have been emerging. In earlier research, Karlsruhe has been identified as a 'mature habitat' for experimentation (Van den Heiligenberg et al., 2018). In this research we found not only that many experiments emerge in this city-region, but also that many disappear or are transferred.

Transfer pathways
Between successive experiments, there is a transfer of mainly practical know-how and experiences. In two cases an administrative tool was also transferred.

The transfer takes place mostly in bilateral and network meetings. In four of the six sending experiments, a signifier was used (i.e. a distinct name concerning a general concept). The signifiers were used for the sending as well as the receiving innovation, such as a *Quartiersprojekt* (a district project) and a *Leihladen* (a rental shop). The names of these recipes are well-known in Germany; this facilitates the diffusion of these innovations. As stated by Loorbach et al. (2020), "Individuals pick up ideas from the media and start a similar initiative". However, these innovations were not replicated or imitated (i.e. transferred unaltered); de-contextualisation and re-contextualisation took place and only a part of the experiment solution was copied.

Receivers indicated that they not only used the innovation received from the identified sender, but also used various other sources for developing their innovation (mostly two to five sources). The resulting experimental solution was mostly a fusion of various parts from various senders. This fusion process sometimes goes hand in hand with a growing professionalism.

Table 4.4. Overview of the findings in the Karlsruhe – future district case

sending experiment (all located in Karlsruhe)	**receiving experiment and location**	**transfer pathway: what was transferred?**	**transfer pathway: how was it transferred?**	**localised context conditions**
project on beekeeping: community gardening and beekeeping & connecting to the soul	urban gardening project (Karlsruhe)	• practical knowledge • codifiable knowledge*	• contact on network meeting • face-to-face contact on festivals • email	• trust and openness • vibrant environment • festivals • network meetings • hub for transfer
project on creative workshops: contributing to community building	project on district activities: organising creative activities, lectures and meetings (Karlsruhe)	• formula* • general ideas* • experiences*	• bilateral face-to-face contact • network meeting	• trust and openness • creative culture • cooperative culture • regional conferences • network meeting • support from local government • support from university
project on renting cargo bikes for free	cargo bikes (Karlsruhe)	• information* • experience* • tool*	• bilateral face-to-face contact • media	• shared sustainability ambition • sustainability subculture • intercity network • festivals
sustainable clothing for children: producing and selling sustainable, fair-trade and locally produced clothing	renting clothing for children: renting clothing with sustainable criteria (Halle, Germany)	• know-how on producing* • criteria for products*	• bilateral face-to-face contact • internet	• trust • trade fair • support local government
borrowing shop for free: renting household devices	borrowing shop for free: renting tools, instruments and toys (Stuttgart, Germany)	• codifiable knowledge	• phone	• openness • vibrant environment • global network • support from university
first shop on borrowing electronic devices for free: renting tools and devices	second shop on borrowing electronic devices for free: renting tools and devices (Karlsruhe)	• practical experience (know-how on doing it) • ideas • tools	• contact on meeting • contact on festival • transport	• shared sustainability ambition • festivals

* This information on what was transferred was mentioned by the sender or receiver only, and not confirmed by their counterpart.

Successive experiments have emerged in other districts in Karlsruhe, and this

indicates an embedding of the sending experiments in the political and cultural context. Moreover, experiments have been transferred to other medium-sized cities in Germany, i.e. Stuttgart and Halle. Previous experiments in Berlin were often mentioned as important pioneers, and these acted as sources of inspiration.

Localised context conditions enabling transfer and harbour
The pioneers in Karlsruhe are part of a supportive general regional culture; several interviewees emphasised the mindset in the region Baden-Württemberg. Elements of this culture include a liberal, open-minded, pragmatic and mutually supportive attitude.

The most important enabling context conditions for transfer are vibrant environments, cultural conditions and network membership. In Karlsruhe, festivals and fairs are important vibrant environments. Maskell et al. (2006) describe how conferences and fairs act as temporary proximities and meeting places for business people, at which a transfer of knowledge and ideas takes place. Festivals may have the same role for sustainability innovations. As one of the interviewees stated, “Festivals are very important for me. I meet the important stakeholders there. The diversity of the network is essential, and also the shared sustainability values of the network members” [interview no. 2.11].

The most important cultural conditions for transfer are formed by trust and by a shared sustainability ambition. One of the interviewees formulated the importance of a shared ambition quite clearly: “We are members of a new subculture with a new lifestyle; we have a task in helping other communities to do the same” [interview no. 2.5]. The local networks are especially important for knowledge transfer in the city. These network meetings are organised by the local government and by the university. They support the citizen groups by providing infrastructure, a meeting place, an existing network, public relations, funding and legitimisation.

An important non-localised condition in this case is publicity for the experiments. We regard publicity as a non-localised condition since it does not necessarily vary across space.

4.4.3 Valencia – science park

Experiments
In the Valencia region, many sustainability experiments with technological innovations are carried out, for instance in food (e.g. biological agriculture), energy

(e.g. ICT and technology), mobility (e.g. electric vehicles), circular economy (e.g. plastics) and water (e.g. saving water). We analysed technological innovations in firms, mostly start-ups, and the transfer of these innovations to other companies.

Table 4.5. Overview of the findings in the Valencia – science park case

sending experiment (all located in Valencia)	receiving experiment and location	transfer pathway: what was transferred?	transfer pathway: how was it transferred?	localised context conditions
firm on water-saving technology	R&D firm (in different country)	• knowledge about technology* • knowledge about tests*	• workshops	• regional openness • vibrant environment • regional networks • regional specialisation
start-up firm on solar energy for industrial processes	firm on solar energy for industrial processes (Freiburg, Germany)	• ideas and insights* • practical knowledge* • knowledge about technology* • customer information*	• email/phone • personal visit	• international meetings • regional/national/ EU funding
start-up firm on car sharing for daily travel	competitor on car sharing (Paris, France)	• technological information* • customer information*	• contact on international fairs	• openness • international events and fairs • university and students
firm on energy-efficient heating with microwave technology	firm on energy-efficient heating with microwave technology (university city, The Netherlands)	• device • knowledge about technology*	• meetings	• trust • collaborative space • local network • global sustainability network • universities
start-up firm on using ICT to prevent food waste	start-up firm (social enterprise) on food donations and food waste (Castellon, Spain)	• technological information • customer information	• meeting	• shared sustainability ambition • meetings, fairs and conferences • co-working space • stakeholder networks • start-up association
start-up firm on CO_2 reduction protocol	association of firms in industrial area (Valencia, Spain)	• protocol • knowledge • advice*	• training	• open-mindedness • shared sustainability ambition • local conferences

* This information on what was transferred was mentioned by the sender or receiver only, and not confirmed by their counterpart.

The experiments often use codifiable knowledge and are often located in a 'science park' environment with a strong university-industry relation (see Table 4.5).

Transfer pathways
The majority of firms use highly specialised technological knowledge. This knowledge is transferred to firms in the same sector, mostly in meetings. The transfer of this knowledge requires face-to-face contact.

Replication did not occur; every firm developed its own unique innovation, based on the global and regional circulation of expert knowledge in dedicated networks and via international project cooperation.

We did not observe a strong embedding of the innovations in the local cultural or institutional context of Valencia. Therefore, de-contextualisation and re-contextualisation processes were not strong. The only exception was an innovation on preventing food waste, which may be embedded in local practice and which was transferred to a city nearby.

Most of the interviewees wanted to protect their innovation. They patented their innovation and some had a non-disclosure agreement with their major partners. In the interviews, three firms did not wish to identify their main partners. This high level of protection and confidentiality may hamper the diffusion of innovations (although patents may also encourage diffusion under certain conditions, see OECD (2004)). Some interviewees were aware of this possible tension. As one interviewee stated, "Now that I know more about saving the planet, I am more open to sharing my technological knowledge" [interview no. 3.3]. The firms not only used the innovation from the identified sender, but used various sources, such as other firms, universities, research companies and local governments, for developing their innovation in a fusion process.

Transfer took place to firms in other university regions in Spain and in other European countries. The receiving regions show economic similarities to Valencia: they are all knowledge-intensive university cities. It is not a one-way transfer; almost all of the interviewees indicated that the transfer is part of an interactive circulation of knowledge.

Localised context conditions enabling transfer and harbour
For transfer of innovations, the vibrant environment of the Valencia city-region is of eminent importance. Firms build networks, and they exchange information and

knowledge in a large variety of meetings, conferences, fairs and co-working spaces. Festivals are not important; one interviewee stated that “the visitors of festivals are not interested in innovations” [interview no. 3.9]. In addition, the importance of networks was mentioned in 50% of the interviews. Various regional networks are important, including expert networks, start-up networks and multi-stakeholder networks; in addition, one interviewee indicated that he transferred knowledge in specialised expert networks on a global scale [interview 3.7].

A number of cultural conditions were considered important enablers, especially regional openness and a shared sustainability ambition in the region. Openness may be at odds with the wish to protect the innovation. As one interviewee indicated, “We have to be open, but at the same time we have to be careful and cautious” [interview no. 3.5].

The universities in Valencia are important regional enabling actors. They transfer knowledge, they organise conferences and they have students who are interested in acting in a pioneer user group for testing innovations.

A few interviewees mentioned the importance of media attention for the transfer of innovations, which is a non-localised condition [interviews nos. 3.9 and 3.10].

4.4.4 Toulouse – fab region

Experiments
In the Toulouse region, many grassroots experiments with technological innovations are carried out, for instance in approximately 35 fab labs, about 15 repair cafés, a hacker space, ICT associations and electronics associations. We analysed the innovations developed by a few ‘makers’ in fab labs and by people in repair cafés, and their transfer towards successive experiments. The fab lab innovations mostly use codifiable knowledge or actual computer code (see Table 4.6).

Transfer pathways
In the makerspaces of Toulouse there is a focus on the transfer of codifiable technological knowledge on ‘how to make it’. Furthermore, there is a transfer of best practices and tools. Even this codifiable knowledge required face-to-face contact for transfer.

Although there is a strong open-source mentality in the community, the transfer of innovations in fab labs was often problematic. Replication did not take place and

recipes were not used: “Everyone is trying to develop their own version of the same thing” [interview no. 4.5]. In the fab labs we noticed an atmosphere of creativity and self-expression, but no interest in diffusion.

In the repair cafés, there was more attention to the transfer of the ‘whole solution’, including social and organisational elements. Still, replication did not occur, which indicates a re-contextualisation process. In the region, the generalised global recipe of the repair café has a distinct name (*Café Bricol*), although there has been some discussion about using the global or the regional name. As one interviewee stated, “I wanted to use the same name, but it was not possible” [interview no. 4.12]. This transfer takes place in face-to-face contact. In the discussions, attention was paid to the value of becoming a member of the transition movement. The approach has been very successful; the growth of the number of repair cafés is remarkable. At this moment, more than 15 repair cafés have been established in the region, and some volunteers now earn a salary from them.

The global fab lab community has a strong open-source and sharing culture, and most labs are members of a strong global network with strong similar institutional characteristics (most fab labs have signed the ‘fab lab charter’). These similar characteristics could enable a global transfer of innovations between labs. However, the innovations that we analysed were mostly transferred to nearby locations in the same city. Another possible pathway for the transfer of fab lab innovations is the pathway to incubators and firms. However, earlier research observed that this route is problematic (Van den Heiligenberg et al., 2018). There was one successful example; this was a maker who ‘transferred’ himself and started his own company.

Repair cafés transferred their solutions to other similar locations nearby, within the city or to another city in the region. Compared to fab lab innovations, the repair café solutions were probably more embedded in the local cultural and institutional context. This may hamper the transfer over larger distances to locations with non-similar characteristics.

Table 4.6. Overview of the findings in the Toulouse – fab region case

sending experiment (all located in Toulouse)	receiving experiment and location	transfer pathway: what was transferred?	transfer pathway: how was it transferred?	localised context conditions
creative prototype at fab lab	innovation at incubator (Mumbai, India)	• documentation* • computer code* • ideas*	• email • contact on festival	• open-source mentality • shared sustainability ambition • global network
energy prototype at fab lab	part of energy prototype (Toulouse)	• knowledge about technology • equipment*	• bilateral face-to-face contact	• open-source mentality • shared sustainability ambition • community meetings • conference • skilled people
biotechnology prototype at fab lab	start-up firm on biotechnology (Toulouse, France)	• prototype	• carried by person	• open-source mentality • festivals • conferences • regional network • local government
fab lab innovations	fab lab innovations (Naples, Italy)	• knowledge* • best practises*	• international project	• social/cognitive proximity • festival
repair café for bikes	repair café (Albi, France)	• practical experience (know how to do it) • tools	• carried by person	
repair café	repair café (Toulouse region)	• major part of solution • principles*	• bilateral face-to-face contact	• openness • shared sustainability ambition • festivals • local/regional networks

* This information on what was transferred was mentioned by the sender or receiver only, and not confirmed by their counterpart.

Localised context conditions enabling transfer and harbour

interviewees emphasised a dominant role of festivals for the transfer of innovations [interviews nos. 4.1, 4.2, 4.5, 4.6, 4.7, 4.11 and 4.12]. Members of a countercultural movement in Toulouse meet at a yearly festival, which has about 35,000 participants (Van den Heiligenberg et al., 2018). The global fab lab community organises a yearly festival, which was held in Toulouse in 2018. In addition, smaller festivals, community meetings and conferences are organised in the city and the region. These festivals may act as temporary proximities, where like-minded people from the same

community meet, discuss and transfer ideas and innovations.

The shared sustainability ambition in various communities is another major enabler in the transfer of innovations. We observed a diverse palette of communities and ambitions. The fab lab community is a global community, with self-sufficiency and open source as its main ambitions. The low-tech community, on the other hand, is a global community but also has regional and local groups. These groups all have shared sustainability ambitions. The repair cafés are part of a local and regional community centred around sustainability and circularity. Some interviewees mentioned these communities and networks as enablers for transfer. The networks may operate on a regional scale (in the case of repair cafés) or on a global scale (in the case of fab labs). For the interviewees, communities and networks are probably overlapping concepts.

In Toulouse, the local and regional governments play a distinct role as enabling actors for the transfer of innovations. They have formulated an ambitious open innovation and open source strategy for the region (Van den Heiligenberg et al., 2018).

As most important project-internal conditions, the interviewees mentioned the documentation of fab lab prototypes, the skills of the people involved, the openness of the sender and the use of a signifier. As a non-localised context condition, they mentioned the media attention for the sender.

4.4.5 Comparison of the four city-regions: transfer pathways and harbours

We compare the cases on two main elements of our conceptual framework: the transfer pathways and the harbours. We observe a marked contrast in transfer pathways between the cases, mainly along the ‘knowledge’ dimension, i.e. the use of codified versus tacit knowledge in the experiments (see Fig. 4.3). We did not find large differences along the ‘governance’ dimension, i.e. between the guided and the grassroots experiments.

The transfer pathways are compared in Fig. 4.4. The technological parts (containing mainly codified knowledge) of the innovation are transferred relatively easily during various meetings; they are not strongly embedded in the regional context. This is most clearly visible in the case of the Valencia – science park. Here, innovations travel over larger distances to city-regions with similar economic characteristics. For the social innovations (in the cases of the Karlsruhe – future district and the Budapest

– local urban food), the transfer of innovations is more challenging. The experiments in these cases transfer practical knowledge during meetings and at festivals. The transferred knowledge has probably a more tacit character and the innovations are more embedded in the local cultural and institutional context. This may hamper translocal diffusion. On the other hand, the use of signifiers (i.e. distinct names concerning general concepts) may enable translocal diffusion (Silva et al., 2016). In our research, it was clear that some of the signifiers are known locally (such as the *Quartiersprojekt* in Karlsruhe), others are known regionally or nationally (such as *Szatyor Bolt* in Hungary, *Leihladen* in Germany and *Café Bricol* in the Toulouse region), and others are known globally (such as repair café). The spatial scales at which these recipes are known may influence their visibility and findability for potential successors who want to start a similar initiative, and thus they may influence translocal diffusion patterns.

Besides economic similarities, there are also other similarities between the sending and receiving regions that may facilitate the transfer. In the Toulouse – fab region and the Budapest – local urban food case, the innovations are transferred to other locations in the same district, city or region, which have similar cultural and political characteristics. The Karlsruhe – future district case shows that similarities can also be found in other cities in the same country. Finally, the fab labs in Toulouse show a high institutional similarity with other fab labs in the world. However, this did not result in frequent global transfer, since other factors hampered this transfer.

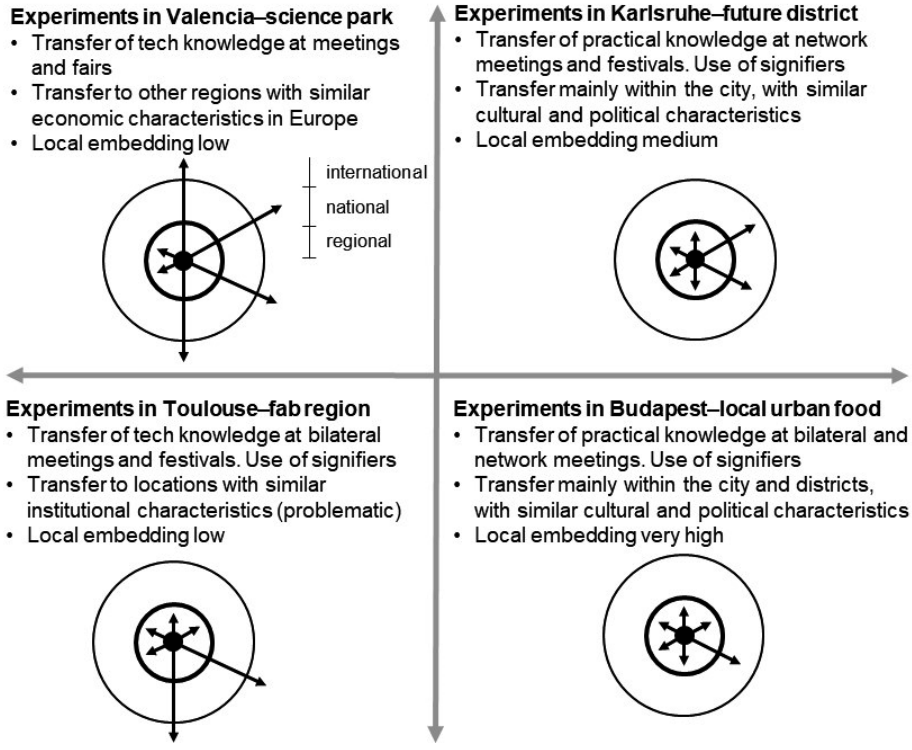

Fig. 4.4. The main contrast in the transfer pathways in the four cases. The schematic maps indicate the spatial transfer patterns of innovations to other locations in the region, in the country or outside the country. Each arrow represents the actual transfer of an individual project, as analysed in this Chapter.

We also compare the cases on the local and regional context conditions (see Fig. 4.5), and on the importance of their combination (harbour). The contrast between the cases is visible in the transfer pathways but is less clearly present in the local and regional context conditions. We observe however some notable differences between the cases, especially in the type of enabling cultural conditions, the type of enabling networks and in the type of enabling government support. The social innovations are enabled by trust, this condition is not mentioned for the technological innovations. The technological innovations are enabled mostly by regional networks and by global networks (with a regional actor as a member of these networks), whereas the social innovations are enabled mostly by local and regional networks. In contrast to the technological innovations, social innovations are enabled by various forms of government support, such as financial support, organisation of network meetings, and publicity for the most innovative examples, for example by organising contests or by giving media attention to the innovations.

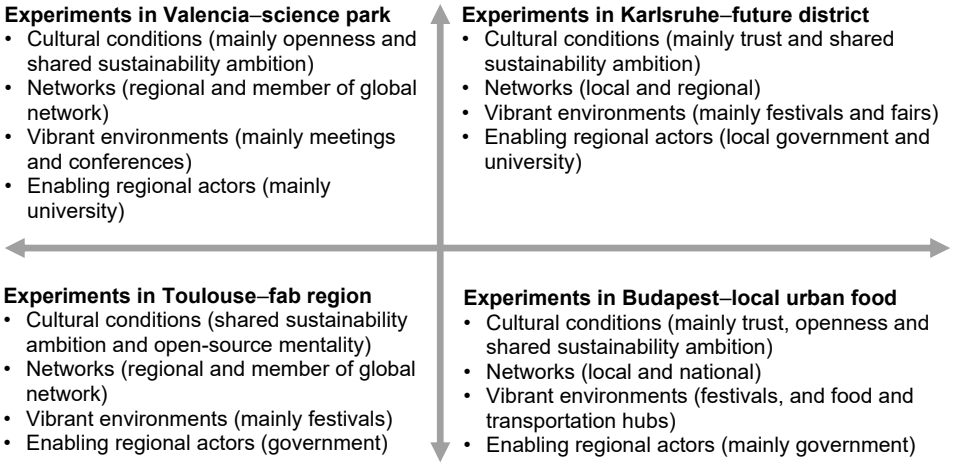

Fig. 4.5. Comparison of the localised context conditions in the four cases

In all cases we found that the transfer of innovations is enabled by a **combination** of local and regional context conditions, i.e. by a harbour:

- In the Budapest case the transfer of knowledge takes place in *vibrant environments* (such as festivals), where the subculture meets. Local food *networks* support this transfer.
- In the Karlsruhe case the knowledge transfer is supported by local urban *networks*. These networks are organised by *regional actors* (the government and the university). In these networks the *cultural conditions* (e.g. trust) are essential.
- In the case of Valencia, regional and global *networks* exchange knowledge in a large variety of *vibrant environments* (e.g. meetings and conferences). Some of these conferences are organised by *regional enabling actors* (i.e. the university).
- In the case of Toulouse, the transfer of innovations is enabled by communities and regional and global *networks,* with shared *cultural conditions* (e.g. a shared sustainability ambition).

Regarding issues of scale, in this study we found that the various context conditions enabling transfer are mostly present on the spatial scale of a city (such as vibrant environments) or a region (such as some enabling regional actors). However, In the Budapest case some cultural conditions are located on the scale of a district, related to the localised density of countercultural groups on that scale. On the other hand, some enabling networks in the Valencia and Toulouse case had a global character.

Table 4.7. The main contrast in transfer pathways, harbours and project-internal conditions for experiments for technological and social innovations.

	Experiments for technological innovations transfer mainly codified knowledge…	Experiments for social innovations transfer mainly tacit knowledge…
Transfer pathways	…and for various sectors they are little embedded in local cultural and institutional contexts…	…and they are intermediately to highly embedded in local cultural and institutional contexts…
	…and this may enable their travelling around the globe…	…and this may hamper their travelling, which is limited to locations with similar characteristics nearby…
		…however, these spatial transfer patterns are influenced by the recognisability and the visibility of the recipes…
Harbours	…this travelling may be enabled by (a combination of) regional and global networks,…	…this travelling may be enabled by (a combination of) local and regional networks,…
	… some government support (visioning)…	…various forms of government support (funding, organising network meetings, publicity)…
	…and cultural conditions and generic vibrant environments…	…and cultural conditions (including trust) and generic vibrant environments
Project-internal conditions	…and their transfer is sometimes hampered by essential project-internal conditions	

Table 4.7 presents the main overall contrast between the four city-regions with respect to the type of experiments, the transfer pathways and the harbours. This contrast is mainly present between experiments for technological and social innovations. The Table also illustrates that there are various factors shaping the transfer pathways, including the traveling distances: the type of knowledge transferred, the degree of local embeddedness, similarities between sending and receiving region, the recognisability of recipes and various localised context conditions.

4.5 Discussion

The aim of this Chapter is to articulate the mechanisms involved in the transfer of innovations to other locations, including the local and regional context conditions enabling this transfer. Our main finding is that there is a sharp contrast in the pathways for experiments for technological innovation versus those for social

innovation. With respect to the local and regional context conditions, we identified four context conditions enabling transfer. The contrast between the local and regional context conditions for the various types of experiments is low. In this section we discuss (i) the usefulness of the framework and (ii) the wider applicability of the results. We add a point of discussion regarding a remarkable finding compared to the current literature, namely (iii) the absence of replication.

The first point of discussion is how the novel conceptual framework proposed in this Chapter adds to our understanding of the transfer of sustainability innovations. Our conceptual framework brings together three building blocks from two different streams of literature. These building blocks were often used in the literature individually, but not in combination: experiments (Van den Heiligenberg et al., 2017), transfer pathways (Williams, 2017) and harbours (Torrens et al., 2019). We have shown that these building blocks are important in combination when analysing the translocal diffusion of sustainability innovations. We have shown that the various types of experiments travel through different transfer pathways, that this travelling requires several similar characteristics between the sending and receiving regions, and that the transfer is enabled by some different but mainly corresponding localised context conditions.
Regarding the differences in the localised context conditions, the contrast in general is low. We found however some notable differences between technological versus social innovations. This contrast is present for the following conditions: global networks, trust and government support. The importance of global networks for technological innovations can be explained by the found larger traveling distances of these innovations. Regarding trust, from the literature is known that compared to codified knowledge, the transfer of tacit knowledge requires more face-to-face interaction. For this, trust is of vital importance (Asheim & Gertler, 2006). With respect to government support, apparently the transfer of social innovations is enabled by various forms of support; in the Karlsruhe case we observed a highly involved local government, giving support to the projects in various ways, by funding, organising network meetings and by giving publicity to the projects. We did not analyse whether social innovations need more forms of support for their transfer then technological innovations; it may be related to the absence of a market potential for some of these projects.

With respect to the local and regional context conditions, from the plethora in context conditions mentioned in the literature (see Table 4.1), we identified that there are four categories of conditions that are relevant to sustainability innovations: cultural conditions, networks, vibrant environments and a few enabling actors. Two of the

context conditions belonging to these categories are understated or even absent in the current literature. The first is a shared sustainability ambition (which is a part of the category of cultural conditions). Although this factor is often mentioned in the literature as part of an articulated vision (Kemp et al., 1998), in this research we found an importance of a shared sustainability ambition in the community, and also between sending and receiving communities. The second is festivals (which are a part of the category of vibrant environments). Festivals play a remarkable role in fuelling the transfer of sustainability innovations. They can be conceptualised as temporary proximities where inventions are on display (Maskell et al., 2006). In economic geography literature, these proximities, such as fairs and conferences, are concentrated on the gatherings of people from firms. In our research, we observe that these gatherings are especially important for people with a shared sustainability ambition. Festivals are probably favourite meeting places for these people. This is also illustrated by our finding that face-to-face contact is used in about three quarters of the transfers. Festivals may be used by elites to establish a social distance between themselves and others (Waterman, 1998). This is reflected in our research, where countercultural groups gather to show and to discuss their sustainability innovations. In earlier research, it was observed that in Toulouse, 'alternatives' meet at a large festival, possibly rebelling against the mainstream (Van den Heiligenberg et al., 2018).

In all the four cases we found that the transfer of innovations is enabled by a **combination** of local and regional context conditions, as suggested in the literature concerning the harbour concept (see the Theory Section). To summarize the findings on this combination, we found that the transfer of innovations is enabled by *local and regional networks*, and that the members of these networks meet on *vibrant environments*, such as meetings, conferences and festivals. Some of these meetings are organised by *regional enabling actors*, such as the government and the university. In these networks, the *cultural conditions* (such as a shared sustainability ambition) are essential for transfer.
These findings demonstrate that the combination of localised context conditions may strengthen each other, e.g. the cultural conditions may strengthen the enabling role of networks.

The *second point of discussion* is the wider applicability of the results. Although there is a long history of studying the transfer and diffusion of innovations in general, the current Chapter is one of the first to systematically analyse the pathways and enabling conditions for the translocal diffusion of sustainability innovations. In order to cover the large variety of sustainability innovations, we selected contrasting cases

that provided valuable insight into the various transfer mechanisms. Nevertheless, there are still important data limitations. The main limitation is that we analysed four distinct types of experiments in four city-regions only. Another type of experiments, for instance in another sector, in one of the four analysed city-regions may show different transfer pathways and different enabling localised context conditions. Furthermore, the four analysed cases will probably not cover the large variation in experiments and regional contexts in Europe. For example, city-regions may show great variation with respect to openness (such as city-regions in remote areas versus hubs with a high centrality), or with respect to distinct institutional, economic, political and cultural contexts. These variations may deeply influence the possibilities for transfer of innovations. We did not include experimentation in rural areas, nor did we execute a comprehensive analysis of receiving regions (we analysed the similarity with the sending region, but we did not analyse the localised context conditions enabling the transfer).

The *third point of discussion* is that replication is found to be almost entirely absent. This is in contrast to the recurring replication mechanism described in some transition literature. This literature may suggest that in the translocal diffusion, the innovation is adopted more or less unaltered by others (Turnheim et al., 2018). Some have a nuanced view on replication mechanisms. They state that although the technology can be replicated into a new context, this also requires an adaptation of the innovation to the local conditions in the new context (Ulsrud et al., 2018). In our research, we observed that 23 of a total of 24 experiments did not show replication, i.e. an unaltered transfer. In almost every experiment, the innovation is 'translated'; what travels is either only a part of the innovation, only the recipe (i.e. the generalised form of the innovation), or only an idea or an inspiration. Even when considering the technological innovations in our analyses, transfer appears not to be limited to a process of de-contextualisation and re-contextualisation; the technology itself is also translated, and this is often a translation towards a new prototype.
Related to this, we may conclude that for several analysed cases the transfer mechanism is not a linear process; here, various sources are used for developing a 'receiving' innovation.

4.6 Conclusions

In this study, we have addressed the following research question: What are typical pathways for the transfer of sustainability innovations to other locations, and how do

local and regional conditions enable this transfer? Our main conclusion is that technological innovations and social innovations travel through different pathways. In general, technological innovations may travel easier around the globe compared to social innovations, they are not strongly embedded in the regional context. However, an important nuance is that various technological innovations in distinct sectors are characterized by a 'customised valuation' system, where products need to be tailored to specific user groups on a local or regional scale. These processes are dependent on the embedding in territorial contexts (Binz & Truffer, 2017). In this Chapter we show that almost all technological innovations were not replicated, but translated. This suggests that in (the early phase of) the innovation process, this customised valuation is the dominant valuation process.
The transfer of social innovations is more challenging. The transferred knowledge has probably a more tacit character and the innovations are more strongly embedded in the local cultural and institutional context. For these social innovations, signifiers are used, which may enable the translocal diffusion.

Our results suggest that the transfer of sustainability innovations to other locations is enabled by a combination of the following local and regional context conditions: cultural conditions (such as openness, trust and a shared sustainability ambition), local, regional and the membership of global networks, vibrant environments (festivals, conferences and fairs), and the presence of enabling regional actors (the government and the university). Finally, we also found some non-localised conditions, such as publicity (media coverage), and some project-internal conditions (documentation and skilled people) that enable transfer.

With these results we have addressed gaps in our understanding of the transfer mechanisms of sustainability innovations and of the conditions enabling this transfer. We have developed a new conceptual framework, in which the translocal diffusion is shaped by an interplay of types of experiments, transfer pathways and harbours.

The findings presented here allow us to derive practical policy recommendations. The intercity and interregional transfer of innovations are important topics for urban and regional policy makers. In the cases we analysed, much government effort has been put into the diffusion of good examples to other locations by providing financial support, by organising network meetings and by organising publicity. Our recommendation to policy makers on the local and regional scale is that they make a tailor-made analysis of the available and necessary pathways and localised context conditions enabling transfer. This may increase the effectiveness of the government efforts on diffusion. Many of these context conditions may be created or

improved by local and regional policy makers and their partners. However, the analysis of the pathways highlights several obstacles for transfer, such as the challenging transfer of social innovations. These obstacles may be difficult to overcome.

We have two suggestions for further research. First, we recommend exploring in greater detail ‘what travels’, as a part of the transfer pathways. A great variety of things may travel, as was proposed in the article by Wieczoreck et al. (2015). However, we observe that most of what travels consists of knowledge (and sometimes of technology). We discovered that this ‘knowledge’ is a broad collection of codified knowledge (such as software code, principles, prototypes and recipes) and tacit knowledge (such as inspiration, ideas, experiences and insights). Further research on what travels may help to gain a better understanding of transfer pathways for these various types of knowledge.

Second, we suggest establishing larger databases on sustainability innovations and conducting quantitative research on the transfer of sustainability innovations, thus capturing the large variation in the types of experiments, the local and regional contexts and their similarities in Europe. This variation may be large, but we are impressed by the shared sustainability ambition that we observed during this research in and across various communities and cities in Europe. This may be a sign that a common sustainability value pattern is emerging, which would be extremely relevant to the sustainability transition.

As an epilogue we would like to remark that the final phase of this research was conducted during the Covid-19 crisis. We assume that the crisis has had little or no impact on the results of this study because the transfers of innovations we analysed took place before the crisis. Nevertheless, this study shows that face-to-face contact was used in about three quarters of the transfers. In post-corona times, certain behavioural restrictions imposed during the crisis may lead to structural changes (such as fewer large-scale festivals or less global travelling). We are interested in and also concerned about the significance of these changes for the future diffusion of sustainability innovations as well as for the speed of change of the global sustainability transition.

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Appendix 4.A

Interview questions and list of interviews

Interview questions

In the interviews with the senders, we raised the following questions:

1a Description of sending experiment. Please describe your innovation (for firms: was it patented)?

1b Possibility for transfer. Was it possible to transfer the results of your experiment to a successive experiment in another location?

1c What was transferred and how? What was transferred to the new experiment (e.g. ideas, knowledge, insights, experienced people)? Was the solution completely copied or only partly?

1d Location of successive experiment. Where is the new experiment located (same region, similar region, same country, different country)? Do you have contact details of the receiver? Do I have your permission to interview the receiver?

1e Conditions enabling transfer. Which conditions were promoting this transfer?

1f Local/regional conditions for transfer. Which regional conditions were promoting this transfer? For example openness of the region, accessibility of the region, membership of networks, cultural characteristics (e.g. open-mindedness, trust), availability of skilled people?

In the interview with the receivers, we raised the following questions:

2a Description of receiving experiment. Please describe your innovation (for firms: was it patented)?

2b What was received? What was received (e.g. ideas, knowledge, insights, experienced people) from previous experiments, especially the experiment XXX (from the identified sender)? Was the solution completely copied or only partly? How was it transferred?

2c Conditions enabling transfer. Which general or regional conditions were promoting this transfer? For example, openness of the region, accessibility of the region, membership of networks, cultural characteristics (e.g. open-mindedness, trust), availability of skilled people?

List of interviews

Budapest – local urban food

Sending experiment (all located in Budapest)			Receiving experiment		
no.	**Interviewee**	**Date of interview**	**no.**	**Interviewee**	**Date of interview**
1.1	Owner of green walls company	27 February 2019	1.2	Owner of vertical gardens company (Budapest)	4 November 2019
1.3	Responsible gastronomy volunteer	5 March 2019	1.4	Restaurant manager (Budapest)*	N/A
1.5	Initiator of local food system	18 May 2018	1.6	Organiser of local food shop (Budapest)	23 October 2019
1.7	Foodbank project manager	28 February 2019	1.8	Foodbank director (Hajdú-Bihar, Hungary)	5 April 2019
1.9	Community gardens coordinator	4 March 2019	1.10	Community garden volunteer (Budapest)	19 March 2019
1.11	Collaborator in food packaging initiative	14 March 2019	1.12	Organiser of food packaging at event (Budapest)	1 April 2019

* Interview did not take place, unable to make contact.

Karlsruhe – future district

Sending experiment (all located in Karlsruhe)			Receiving experiment		
no.	**Interviewee**	**Date of interview**	**no.**	**Interviewee**	**Date of interview**
2.1	Team member of project on beekeeping	6 May 2019	2.2	Coordinator of urban gardening project (Karlsruhe)	1 October 2019
2.3	Initiator of project on creative workshops	7 May 2019	2.4	Team member of project on district activities (Karlsruhe)	7 October 2019
2.5	Team member of project on renting cargo bikes for free	7 May 2019	2.6	Policy advisor on cargo bikes (Karlsruhe)*	N/A
2.7	Owner of shop on sustainable clothing for children	26 September 2019	2.8	Employee of shop on renting clothing for children (Halle)	4 October 2019
2.9	Coordinator of borrowing shop for free	23 September 2019	2.10	Coordinator of borrowing shop for free (Stuttgart)	2 October 2019
2.11	Coordinator of first shop on borrowing electronic devices for free	4 November 2019	2.12	Coordinator of second shop on borrowing electronic devices for free (Karlsruhe)	4 November 2019

* Interview did not take place, unable to make contact.

Valencia – science park

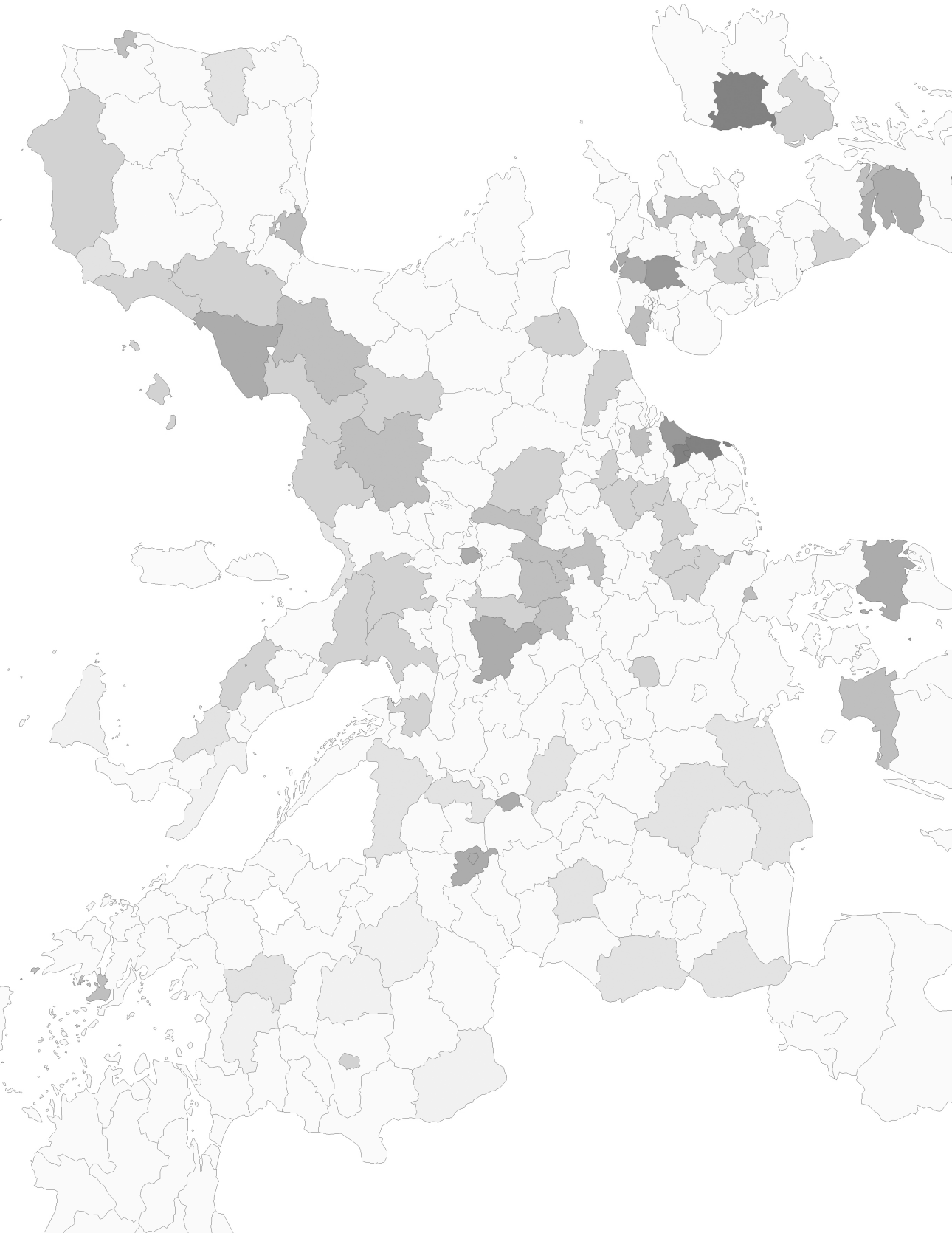
Sending experiment (all located in region Valencia)			Receiving experiment		
no.	**Interviewee**	**Date of interview**	**no.**	**Interviewee**	**Date of interview**
3.1	Researcher at firm on water-saving technology	29 October 2019	3.2	R&D firm (other country)*	N/A
3.3	Founder of start-up firm on solar energy for industrial processes	6 December 2019	3.4	Employee of firm on solar energy for industrial processes (Freiburg, Germany)	23 March 2020
3.5	Founder of start-up firm on car sharing for daily travel	2 December 2019	3.6	Competitor on car sharing (Paris, France)*	N/A
3.7	Researcher at firm on energy-efficient heating with microwave technology	29 November 2019	3.8	Firm on energy-efficient heating with microwave technology (university city, The Netherlands)*	N/A
3.9	Employee of start-up firm on preventing food waste with ICT	3 February 2020	3.10	Employee of start-up firm (social enterprise) on food donations & food waste (Castellon, Spain)	19 March 2019
3.11	Manager at start-up firm on CO2 reduction protocol	9 January 2020	3.12	Manager at association of firms in industrial area (Valencia, Spain)	10 March 2020

* Interview did not take place for confidentiality reasons.

Toulouse – fab region

Sending experiment (all located in region Toulouse)			Receiving experiment		
no.	**Interviewee**	**Date of interview**	**no.**	**Interviewee**	**Date of interview**
4.1	Developer of creative prototype at fab lab	1 October 2020	4.2	Innovation specialist at incubator (Mumbai, India)	9 October 2020
4.3	Developer of energy prototype at fab lab	8 October 2020	4.4	Developer of part of energy prototype (Toulouse)	30 October 2020
4.5	Developer of biotechnology prototype at fab lab	10 February 2020	4.6	Founder of start-up firm on biotechnology; same as sender (Toulouse)	10 February 2020
4.7	Fab lab innovations manager	2 March 2020	4.8	Fab lab innovations manager (Naples, Italy)*	N/A
4.9	Advisor of repair café for bikes	31 October 2017	4.10	Coordinator of repair café (Albi, France)*	N/A
4.11	Initiator of repair café	7 October 2020	4.12	Initiator of repair café (Toulouse region)	29 October 2020

* Interview did not take place, unable to make contact.



Chapter 5

Conditions for the diffusion of sustainability innovations in European regions

Abstract

Large numbers of experiments with sustainability innovations are carried out in various regions of Europe, and these innovations also diffuse. This diffusion is important for the transition towards sustainability. Project-internal conditions (especially the technical quality of the innovation and the activities aimed at media attention) as well as local and regional context conditions together contribute to this diffusion; the contribution of both groups of conditions in explaining diffusion is about equal in size. In this Chapter we especially investigate the spatial context conditions, using the concept of frontrunner regions. These regions have the conditions for successful experimentation and diffusion of innovations to other locations. After investigating 472 experiments in 89 regions in Europe, we have found that frontrunner regions host a countercultural milieu and offer sustainability networks enabled by a culture of trust and openness. They also provide a vibrant environment and active regional actors. Overall, frontrunner regions are strongly related to cities and regions with a high social and physical openness. This study suggests that within the analysed regions, frontrunner regions are mainly found in Northern and Western Europe, such as the regions of Noord-Holland, Utrecht and Midland & Eastern Ireland, with some isolated hotspots in other parts of Europe, such as Budapest and Catalunya. The innovations in these regions may offer inspiring examples to others, thus accelerating the global sustainability transition.

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5.1 Introduction

The global sustainability challenge requires local experimentation in a real-life context. In these experiments, various types of innovations are tested (e.g. new technologies or new ways of doing things). The real-life setting may help to advance the sustainability transition. Transition literature indicates that this local emergence of experiments may be followed by a diffusion process, in which the innovations gain more users and subsequently spread to other locations. These innovations may challenge the structures of the regime, i.e. the structures of existing systems in societal domains, such as in the domain of energy or food. In the longer term this may lead to a system change (Geels and Raven, 2006). In present times, cities are confronted with a multiplicity of urban societal challenges, such as carbon reduction, adaptation to extreme weather conditions, creation of circular flows of materials and the development of a healthy living environment. Stakeholders in cities see experimentation with sustainability innovations in a real-life context as a promising new approach in urban governance to find solutions for this multiplicity and complexity of challenges (Bulkeley and Castán Broto, 2013). These innovations cover technological as well as social innovations, and are governed by a variety of actors, such as governments, firms, universities and citizen groups. The diffusion of these innovations is not guaranteed. It is therefore of great societal importance to gain insight into the enabling factors for urban experimentation and the diffusion of these innovations to other locations.

The regions in Europe show large cultural, economic, political and institutional differences. Cultural differences, such as an openness to new ideas (Kaasa and Vadi, 2010) or a low acceptance of power inequalities in institutions (Hofstede, 1980) may shape localised densities of experimentation patterns in a diversity of innovative milieus (Kaasa, 2016). The innovations in these experiments may also diffuse. However, these innovations are often strongly embedded, both locally and regionally, and this may hamper their diffusion to other, dissimilar locations (Van den Heiligenberg et al., 2022). These processes lead to a geographically uneven pattern of experimentation and diffusion in Europe. For instance, Berlin is well-known as a ‘hotspot’ (i.e. a localised high density) of grassroots food experiments (Wendler, 2016), and Barcelona is noted for its experiments in fabrication labs (Hielscher et al., 2015). These cities and regions may act as frontrunner regions, i.e. regions with favourable spatial context conditions for experimentation and diffusion, thus acting as an example for pioneers and regions in other locations.

From the current literature it is known that successful experimentation and translocal

diffusion are enabled by project-internal as well as spatial context conditions. These context conditions are mainly – but not exclusively – present on the local and regional scale (Van den Heiligenberg et al., 2022, 2018). Cities and regions offer the 'test-beds and seedbeds' for sustainability experimentation (Frantzeskaki et al., 2018). Translocal diffusion often requires other or additional context conditions, compared to experimentation (Van den Heiligenberg et al., 2022). The current literature offers only a limited understanding of these context conditions. Most research into the geography of transitions consists of single case studies, often focusing on an 'alternative' village or city. Here, countercultures play an important role, as they shape a beneficial context for experimentation through alternative ideas and lifestyles (Van den Heiligenberg et al., 2018). In the few quantitative studies available, the membership of transnational city networks is mentioned as an important factor enabling diffusion (Castan Broto and Bulkeley, 2013; Davies et al., 2017). However, until now, there has been no systematic quantitative analysis of the enabling conditions for sustainability experimentation and diffusion in a variety of European urban contexts. Such an analysis would help to better understand the geographical unevenness of experimentation and diffusion.

Our research question is the following: which project-internal and spatial context conditions enable the translocal diffusion of sustainability innovations in Europe, and which type of regions in Europe are frontrunners in this diffusion? This research focuses on the diffusion of experiment-based technological and social innovations tested in practice, i.e. in real-life situations, by a broad range of actors. We include the project-internal conditions in order to be able to make statements about the relative contribution of project-internal and context conditions in explaining diffusion. However, this research focuses mainly on the spatial context conditions. Here, we observe a strong interest from practitioners, who wish to gain more insight into these conditions. In line with what was found in the literature, this research focuses on the context conditions on a local and regional scale; wherever relevant, it aims to cover other scales, too. To obtain a closer characterisation of the types of regions acting as frontrunners, two combinations of regional indicators are also analysed, representing two important characteristics of innovative regions from the literature: openness and creativeness.

Recently, it has become clear that even though the diffusion of innovations is to take place in future, it is already possible to improve the 'transformative potential' during the experimentation (Ghosh et al., 2021; Wolfram et al., 2019). Therefore, this research includes the context conditions that have this potential.

In the empirical part of this research, the Urban Nature Atlas is used; this is a dataset on urban nature-based solutions (Almassy et al., 2018). Nature-based solutions are deliberate interventions that can be inspired by or that support nature in addressing urban challenges (Bulkeley et al., 2017). The database contains a heterogeneity of projects, such as social innovations (e.g. in community gardens) and technological innovations (e.g. in green facades)(see Dignum et al., 2020). These projects are led by various actors: governments, NGOs, firms and citizen groups. Dignum et al. (2020) found a number of socio-spatial conditions that enable the emergence of nature-based solutions, such as local policies, networks and localised learning; however, they did not analyse diffusion patterns. We build on their research by adding various other context conditions and project-internal conditions, and by analysing whether these conditions explain diffusion patterns.

We believe that this research has an added value for practitioners, especially for stakeholders on a local and regional scale. In the current time of 'governance by experimentation' (Bulkeley and Castán Broto, 2013), these stakeholders may be interested in the conditions facilitating the translocal diffusion of sustainability innovations.

The Chapter proceeds as follows. The next section presents the theoretical foundations, the relevant mechanisms and the hypotheses. Section 5.3 specifies the methods employed, followed by the findings in Section 5.4. In Section 5.5 we test the hypotheses and reflect on the results. In the final section, the conclusions and some suggestions for further research are presented.

5.2 Theory

5.2.1 Theoretical foundations

This study is part of the research on the geography of transitions. The core question in this field is where new sustainability developments are likely to happen, and which sort of local contexts are amenable to the creation of novel configurations that work (Truffer, 2016). In this relatively new research field, a thorough theoretical basis is lacking; this is why we consult two other fields of research which may be regarded as antecedents of the geography of transitions research: transition studies and regional innovation systems research.

Transition studies
In transition studies, the strategic niche management concept has been developed

to analyse sustainability experiments and to identify the enabling conditions for the diffusion of these experiment-based innovations towards a system change. A niche is considered as a protective space that allows for experimentation, by nurturing processes and shielding (Schot and Geels, 2008; Smith and Raven, 2012). This protection is needed to prevent innovations from being exposed to the harsh selection pressures of the existing regime (Sengers et al., 2016). In transition studies, a niche is not geographically articulated, although there are several indications that niches have a localised character. For instance, niches may be remote geographical spaces, outside the reach of centralised energy grid infrastructures. Also, niches may be institutional spaces with an environmentalist milieu with different cultural values (Smith and Raven, 2012). In a paper from 2015, Hansen and Coenen state that "context and scale matter in sustainability transitions, but it is unclear *how* context and scale matter" (Hansen and Coenen, 2015).

Regional innovation systems research

In Regional innovation systems (RIS) research, there is a long tradition of analysing the spatial context conditions that enable innovation. RIS research mainly focuses on innovations carried out by firms. In our research we are also interested in other actors; however, we use the main RIS concepts. Several authors have emphasised the importance of the local and regional conditions explaining the differences in localised densities in innovation activities, such as knowledge spillovers (Jaffe et al., 1993), proximity (Boschma, 2005) and regional capabilities (Neffke et al., 2011). Various researchers emphasise the importance of these conditions being present in combination (Aydalot, 1986). In a regional innovation system, these elements are integrated, including the institutional and organisational support structures (Asheim et al., 2016).

Despite the localised character of innovation activities, an important question in RIS research remains whether successful innovation may be explained mainly by the micro or by the macro scale, i.e. by project-internal factors or by the local and regional context factors. A related question is whether a high density of innovation activity would be the result of a spatial sorting process of people, firms and other actors, (which is defined as the process of these actors moving to attractive regions), or rather the result of a long-term regional path-dependent development and embedding process (Van Oort, 2018). Behrens et al. (2014) analysed productivity in large versus small cities, and suggest that higher productivity in large cities is explained by the sorting processes of talented individuals, by productive entrepreneurs and firms as well as by agglomeration economies. They suggest that the combination of these elements is important and that they complement each

other. It is not clear whether these sorting processes are also relevant for sustainability innovations, but in our research the project-internal and context factors are compared. Van den Heiligenberg et al. (2017) found that the project-internal and context conditions contribute equally to successful experimentation with sustainability innovations.

Finally, we would like to remark that besides the insights from regional innovation systems research, there are indications that the national scale is also relevant for innovation, for instance in a variety of institutional settings, government policies and cultural traditions (Freeman, 1995).

Research on the geography of transitions

In research on the geography of transitions there are indications that spatial context and scale matter for the emergence of experiments with sustainability innovations and their diffusion, but the image is still fragmented. Most of the research in this field consists of single case study research, for instance research on an 'alternative' village or city, such as an intentional community (Fois, 2016), a transition town (Longhurst, 2015) or a 'green' city (Torrens et al., 2018). In these villages and cities, countercultural movements play an important role in shaping a beneficial context for experimentation through alternative ideas and lifestyles (Van den Heiligenberg et al., 2018). In quantitative studies, the most important enabling factors found are the membership of transnational city networks (Castan Broto and Bulkeley, 2013; Davies et al., 2017), the relationship with university towns (Davies et al., 2017), a supportive government (Davies et al., 2017; Feola and Butt, 2017), gentrifying and income-deprived neighbourhoods (Håkansson, 2019) and vibrant environments such as fairs and conferences (Feola and Butt, 2017).

Frontrunner regions

In innovation research, the concept of frontrunner regions is well known. De Wald and Truffer (2012) analysed leading regions in installed PV capacity in Germany. Zubaryeva et al. (2012) described the concept of regional lead markets. In these regions a particular innovation is used earlier than in other regions, and there is a higher probability that the innovation will be adopted by others. Irvine and Bai (2019) analysed a frontrunner city, and they defined frontrunner cities as cities engaged with ongoing sustainability experimentation, often becoming the beacon for others to follow. Our research proposes a similar concept. We define a frontrunner region for sustainability experimentation as a region with favourable spatial context conditions for experimentation and diffusion, thus acting as an example for other pioneers and other regions. It is important to remark that we do not suggest that the innovations

tested in frontrunner regions would be universally desirable (Torrens, 2019).

Nature-based solutions
In the empirical part of this research, a dataset on urban nature-based solutions is used. Nature-based solutions (NBS) are deliberate interventions that can be inspired by or support nature in addressing urban challenges, such as climate change mitigation, water management, land-use and urban development (Bulkeley et al., 2017). These solutions are being increasingly applied in and by cities (Fastenrath et al., 2020). Yet, the diffusion and embedding of NBS in urban development is problematic. This may be due to structural regime conditions that keep urban development systems locked in their current state (Dorst et al., 2021). It is not clear yet which conditions enable the diffusion of these solutions (Von Wirth et al., 2019).

5.2.2 Mechanisms

We are interested in the mechanisms underlying the translocal diffusion of sustainability innovations. These mechanisms allow us to pinpoint the indicators needed to identify the conditions enabling diffusion. The theory shows that two dimensions are relevant in these mechanisms, namely (i) the dimension from the experiment towards the region and (ii) the dimension from emergence to diffusion. Fig. 5.1 presents a simple conceptual model.

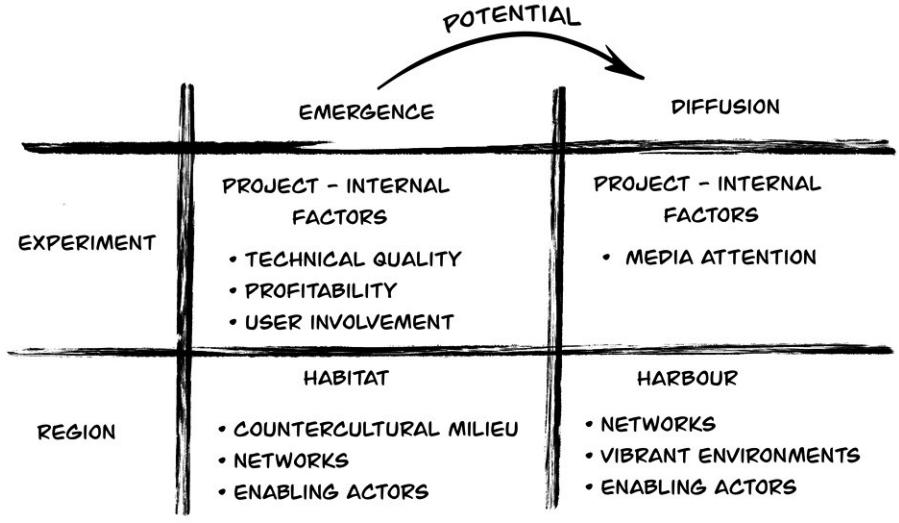

Fig. 5.1. Conceptual model, including the main enablers for emergence and diffusion identified in this Chapter.

The first dimension indicates that project-internal as well as contextual conditions will be included in explaining the diffusion of sustainability innovations. The second dimension illustrates that in explaining diffusion, the conditions enabling the emergence of experiments will be included. This is because it has become clear from transition studies that even though the diffusion of innovations takes place in the future, it is already possible to improve the 'transformative potential' during experimentation (Ghosh et al., 2021; Wolfram et al., 2019).

For the context conditions, we use the habitat-harbour duality as a basis. Van den Heiligenberg et al. (2022; 2017) developed two relevant concepts for experimentation and diffusion, namely (i) an adequate habitat enabling experimentation and (ii) a supportive harbour enabling the transfer and translation of the innovation to other locations. A habitat is defined as a configuration of favourable local and regional context conditions for experimentation, with the potential for future upscaling. A harbour is regarded as a combination of favourable context conditions for transferring the innovation to other locations.

In the descriptions of the mechanisms, the starting point is formed by the mechanisms found in the geography of transitions studies literature, since this literature fits this research best. For experimentation, the following four categories of conditions have been found: project-internal conditions, countercultural milieu, networks and enabling regional actors. For diffusion, the following partly overlapping categories have been found: project-internal conditions, networks, vibrant environments and enabling regional actors. Starting from the geography of transitions literature, additional mechanisms from the general innovation literature have been added to the project-internal factors. Moreover, additional insights from the RIS literature have been added to the local and regional context factors found.

5.2.2.1 Mechanisms for experimentation

Sustainability experimentation in this research involves testing the prototypes of social and technological innovations in a real-life context. This process may be guided by governments or firms, but may also have a grassroots character, and be self-governed, for instance by informal community groups without a clear leadership. In this Chapter we are interested in the prototypes that have not been fully developed yet. This research focuses on prototypes that may already have been tested in the past, but where there is still a great deal of uncertainty whether these innovations will work in real life, in distinct local or regional contexts. The focus of this research is on innovations that are 'new to the region' (Binz and Gong, 2021), and thus not necessarily 'new to the world'.

Project-internal conditions

In the literature on the geography of transitions, we find that in the project itself the *technical quality of the innovation*[7], the *profitability* and the *user involvement* (preferably in a real-life setting) are crucial for advancing transitions (Van den Heiligenberg et al., 2017). In the general innovation literature, some additional insights are found in the mechanisms related to these factors. The technical quality of the invention may open new markets, leading to greater production and employment (Pianta, 2006). The technical quality is of great interest to potential adopters; they are mainly interested in the amount of improvement which the new technology offers over any previous technology (Hall, 2005). We argue that the technical quality is an essential condition; without a distinct technical quality, the diffusion will probably not take place. Related to the technical quality is the profitability, which increases the potential demand in the market (Cohen and Levin, 1989). User involvement is especially important in testing innovations in real-life. The involvement of users in so-called living labs enables the diffusion, since this setting imitates real-life conditions (Schliwa and McCormick, 2016). User involvement may generate valuable experiences; these experiences will display feedback to the innovation process (Hall, 2005), and they may be used to improve the innovation during experimentation (Van den Heiligenberg et al., 2017). However, in projects with a very high degree of user involvement, for instance in grassroots experiments of citizen groups, the potential for diffusion may be low. Grassroots experiments are often inward-oriented (De Moor, 2013). We consider the three conditions mentioned above the most important, since they are directly related to sustainability innovations tested in real-life situations, which is the focus of our research.

Additionally, a few transition scholars mention that the *competences of the actors* are important, such as the ability to consider complex problems at a high level of abstraction and the ability to look beyond the limits of their own discipline and background (Loorbach, 2007). From general organisational innovation and management studies, we learn that every new innovation consists of a combination of existing ideas, *skills* and competences. This may cover a variety of available specialists, enabling the cross-fertilisation of ideas and the availability of technical knowledge sources (Damanpour, 1991), as well as more individual determinants, such as the personality and the motivation of the people involved (Anderson et al., 2004; Crossan and Apaydin, 2010).

[7] In Section 5.2.2.1 and 5.2.2.2, the main conditions in the mechanisms which will be used in selecting the indicators for the statistical analysis are marked in italics.

Countercultural milieu

In the context of the experiments, *countercultural movements* play an important role as the birthplace of major breakthroughs in technological and social innovations. These alternative movements offer a protective space for creating alternative ideas, practices and social relations (Wittmayer et al., 2016). They are very diverse in nature, and they may involve alternative politics (such as 'green' politics), alternative lifestyles and alternative spiritualities (Longhurst, 2015). These movements emerged in the 1960s and 1970s in Western metropolitan centres, often in university cities (Chryssides, 2007; Ivakhiv, 2007), and some of them moved away to rural areas. Members of these countercultures may play a significant role in experimentation on a local or even on a district scale, for instance as pioneer users, participants or stakeholders (Van den Heiligenberg et al., 2018).

Local regional and global networks

Transition studies emphasise the importance of *local and regional networks* (Van den Heiligenberg et al., 2017). In multi-stakeholder networks, social learning takes place around experimentation. The diversity of actors enables a broad understanding of the issues at stake (Sol et al., 2013). In these networks, learning processes are enabled by *trust* (Sol et al., 2013), *openness* (Boschma, 2005) and a *shared sustainability ambition* (Van den Heiligenberg et al., 2022).

In the RIS literature, these regional networks are studied extensively. Several models have been described, such as the triple helix model. More recently the quadruple helix model was presented; in this model, knowledge for innovation is created and disseminated between companies, government, universities and civil society (Farinha et al., 2020).

In urban areas with a high *population density*, there are often more opportunities for learning and knowledge exchange between firms and research institutes (Jaffe et al., 1993). The regions' absorptive capacity further enables the effectiveness of this import of knowledge from other regions (Cortinovis and Van Oort, 2019). *Global networks* have a distinct relevance for the introduction of new ideas from other parts of the world. For knowledge exchange, informal contacts are highly important, brought about by virtual knowledge communities (Trippl et al., 2009).

Enabling regional actors

Compared to economic innovations, sustainability innovations may have more difficulty entering the market. Sometimes the ambition for commercialisation is even

absent, which is why a temporary protective space is required where various forms of nurturing and empowering processes are active (Smith and Raven, 2012). The *government* may play an important *protective role* here, for example by creating an area with *fewer regulations* where experimentation is allowed, or by *funding*.

Experimentation is carried out in distinct local and regional contexts. The local or regional government may develop a sustainability *vision*. A shared vision may create a selection environment; it may guide the innovation process and coordinate the strategies of the stakeholders involved (Kemp et al., 1998).

5.2.2.2 Mechanisms for diffusion

For transitions to take place, the diffusion of innovations is essential. Local experimentation may be followed by a diffusion process towards local growth or towards the transfer of the innovation to other locations. In the long term this may lead to a system change. This transfer is not a simple copy-and-paste process; it usually requires a translation. In early diffusion processes, what travels is often only a part of the innovation or the generalised form. Compared to technological innovations, social innovations may have more difficulty realising this diffusion. These innovations are more locally embedded and their travelling is often limited to nearby locations with similar characteristics (Van den Heiligenberg et al., 2022).

Project-internal conditions

For the transfer of sustainability innovations to other locations, *skilled people* are needed (Loorbach et al., 2020; Van den Heiligenberg et al., 2022); however, the literature is not clear on which skills are needed. The industrial organisation literature states that for innovation, it is important to know how firms create and adapt resources and cognitive competences (Nooteboom, 1999). This may involve an *education of the workforce* or a *spatial mobility of skilled labour* (Bento and Fontes, 2015; Fitjar and Rodríguez-Pose, 2015; Miguélez and Moreno, 2013).

Project activities aimed at *media attention* for experiments may be an important factor, since such attention directly concerns the transfer of knowledge regarding the innovation. In addition, publicity may inspire others to start a successive experiment, and may thus stimulate translocal diffusion of innovations (Loorbach et al., 2020). However, the literature indicates that *face-to-face interaction* plays a more important role for the diffusion (Rogers, 2003; Van den Heiligenberg et al., 2022).

Local, regional and global networks

Various networks enable the translocal diffusion of innovations, and thus they act as

knowledge channels (Van Oort and Lambooy, 2019). On the local and regional scale, this knowledge transfer takes place in specialised *networks*, enabled by various cultural conditions in these networks and also in the general regional context conditions, such as *trust, cultural openness* and a *shared sustainability ambition* (Capdevila, 2018; Lawson and Lorenz, 1999; Van den Heiligenberg et al., 2022). On a global scale, this transfer is enabled by transitions clubs and global *intercity sustainability networks* such as ICLEI and C40 (Castán Broto and Bulkeley, 2013; Davies et al., 2017; Noseleit, 2018; Williams, 2017). Van den Heiligenberg et al. (2022) found that the diffusion of technological innovations is enabled mostly by global networks, whereas social innovations are enabled mostly by local networks. This difference may be related to the larger travelling distances and the low degree of local embedding of technological innovations.

Vibrant environments
In the diffusion of innovations, the transfer of knowledge and ideas in face-to-face interactions between members of sustainability communities and networks is essential. Therefore, various forms of temporary proximities are needed (Maskell et al., 2006), such as *festivals, conferences and fairs* (Feola and Butt, 2017; Rut and Davies, 2018; Van den Heiligenberg et al., 2022).

Enabling regional actors
Distinct regional actors enable the transfer process. *Governments* may develop a *vision* which may guide the transfer of innovations (Schwanen, 2015; Van den Heiligenberg et al., 2017); they are also important for *funding* and for institutional adaptations. They may also give publicity to experiments (Van den Heiligenberg et al., 2022). *Universities* can act not only as gatekeepers in *global knowledge exchange processes* (Kauffeld-Monz and Fritsch, 2013), but they also have a much broader role as regional enablers in sustainability transitions, e.g. by organising *network meetings*, where knowledge transfer takes place.

5.2.3 Hypotheses

In the existing geography of transitions literature, project-internal as well as local and regional context conditions were found to enable the diffusion of sustainability innovations. The general innovation literature offered additional insights into the project-internal factors. The regional innovation systems literature yielded more information with respect to the distinct spatial context factors. We put forward three hypotheses:

1. Project-internal as well as local/regional context conditions enable the translocal diffusion of sustainability innovations (H1); both groups of conditions are needed in combination as they complement each other.
2. The technical quality of the innovation (H2a), user involvement (H2b) and project activities aimed at media attention (H2c) are the most important project-internal conditions. These three conditions are identified as main enablers in the literature. For a fourth main enabler, profitability, there are no suitable data available in the dataset used.
3. Frontrunner regions host a combination of:

    - a countercultural milieu (H3a);
    - a high number of local, regional and global sustainability network connections, supported by trust, cultural openness and shared sustainability values. Furthermore, it is hypothesised that diffusion of technological innovations is enabled mostly by global networks, whereas the diffusion of social innovations is enabled mostly by local networks (H3b);
    - a vibrant environment (H3c);
    - the presence of a number of actors enabling experimentation and diffusion (H3d).

We translate the elements of these hypotheses into indicators, using the mechanisms from the literature. In order to obtain a better picture of frontrunner regions, we have added indicators related to characteristics of innovative cities as found in the literature. These indicators are the starting point of the statistical analysis.

5.3 Method

This research is one of the first to quantitatively analyse the conditions for experimentation with sustainability innovations and the diffusion of these innovations in a variety of regional contexts. Therefore, a research design was developed starting with a correlation analysis with a longlist of variables, followed by a regression analysis with a shortlist of variables. The research design consists of the following three steps: (i) indicator selection, (ii) data collection and (iii) data analysis.

5.3.1 Indicator selection

For the indicator selection, two criteria were used: (i) the indicator should represent

the condition as described in the mechanism and (ii) for the context conditions, the indicator should discriminate between the regions used in the dataset.

5.3.2 Data collection

As a first step, an inventory was made of available European databases, which can be useful for the purpose of this research. We searched for two groups of databases:

a. A database which contains the dependent variable: the sustainability experiments. From the few databases available on a European scale, the Urban Nature Atlas was selected for this research. This is a database of nature-based solutions in Europe (Almassy et al., 2018). We selected this database for the following reasons:

   - The database contains a large variety of sustainability experiments, testing technological as well as social innovations, and a variety of guiding actors. This variety fits our research question.
   - The database contains data representing project-internal conditions, which are relevant as independent variables for this research.
   - The database contains a few fine-grained context conditions, e.g. the existence of a local or regional vision. These data have added value, since they are not available in European-wide databases on a regional scale.
   - The database contains an indication of whether this innovation is based on a previous innovation, and whether this innovation is transferred to a successive experiment. This is relevant for analysing diffusion.
   - However, from the perspective of this research, the database has some important shortcomings: only 100 cities are covered, almost all cities are university cities (it is therefore not possible to test differences between non-university and university cities, which is mentioned in the literature as relevant), the number of experiments per city is maximised to 10 (these numbers are too low to analyse individual regions in detail), and the number of cases is not very high: the transfer is known of 472 cases.

b. Other databases containing independent variables, i.e. regional context variables.

Finally, the database of the Urban Nature Atlas was combined with the other databases containing independent variables. This resulted in a new database, tailored to the needs of this research.

Description of the database of experiments
The Urban Nature Atlas was developed in the Naturvation project (Almassy et al., 2018; see also www.una.city). The database contains a heterogeneity of nature-based solutions, such as social innovations (e.g. in community gardens or orchards for recreation and education), technological innovations (e.g. in green facades and green roofs) and system innovations (e.g. in an eco-friendly city district)(see Dignum et al., 2020). These projects are led by various actors, such as governments, NGOs, firms and citizen groups.

The database contains 976 initiatives in 100 cities, in 90 NUTS2 regions in Europe. They were selected with the aim of covering the diversity in urban settings, sustainability challenges and governance arrangements (Almassy et al., 2018). The urban settings were varied: almost half of the projects took place in parks and urban forest areas, almost 40% were connected to a grey infrastructure. One third of the projects represented blue areas and a quarter of them were related to community gardens or allotments (Almassy et al., 2018). For this research we used 472 cases in 99 cities in 89 regions; for these cases data are available for the dependent and context variables (see Section 5.4.9). An overview of the NBS per country can be found in Table 5.1.

For this research, the city selection is relevant. In the Urban Nature Atlas, the aim was to select the varied urban and environmental conditions in larger cities across Europe, with a population above 250,000 inhabitants and with a broad geographical distribution (Almassy et al., 2018). The diversity in urban and environmental conditions was covered by selecting cities showing a large variation in the following four indicators: unemployment, share of green urban areas and forests, access to green areas and vulnerability to climate risk. The data were collected by analysing secondary sources (e.g. project reports and other project documents, websites, news articles, research articles, studies and blog posts), and by using discourse analysis to extract the data (the intention was not simply to look for terms, such as nature-based solutions, or green or blue infrastructure, but to search for patterns of discourse connected to those terms). The cities included are shown in Fig. 5.2.

Table 5.1. Overview of urban settings of the nature-based solutions from the Urban Nature Atlas, used for this research. A solution (a project) may include more than one urban setting.

Country	External building greens	Urban green space connected to grey infrastr.	Parks and (semi-) natural green areas	Allotments and community gardens	Blue areas	Green indoor areas	Green areas for water management	Derelict areas	Total no. of projects
BE	2	3	3	4	3	2	2	3	9
BG	0	3	5	1	0	0	0	2	7
CH	3	1	2	0	0	0	0	0	4
CZ	1	1	0	1	1	0	0	0	1
DE	7	19	26	13	23	1	13	5	51
DK	3	4	5	0	4	0	5	0	8
EE	0	0	0	0	1	0	1	0	1
ES	7	21	31	15	7	1	6	12	52
FI	3	4	1	5	3	1	4	3	9
FR	2	10	13	16	8	0	5	3	29
GB	14	29	33	23	29	1	15	13	74
GR	2	1	2	2	1	0	1	0	3
HR	0	0	1	1	1	0	0	0	2
HU	1	0	1	1	0	0	0	0	3
IE	0	3	0	1	2	1	2	0	3
IT	6	14	26	14	10	0	0	2	52
NL	6	11	14	15	10	2	10	0	23
NO	5	7	9	1	6	1	7	2	17
PL	17	20	18	8	13	2	7	0	52
PT	2	1	9	3	1	1	2	2	15
RO	3	6	9	5	5	0	1	5	23
SE	9	9	12	6	11	0	7	0	27
SI	0	2	2	2	0	0	0	1	3
SK	0	0	1	0	1	1	0	0	3
Tot.	93	169	223	137	140	14	88	53	472

Fig. 5.2. Cities included in the Urban Nature Atlas (Almassy et al., 2018)

5.3.3 Data analysis

In order to answer the research question, a statistical analysis was carried out, including regressions. The steps in the statistical analysis are presented in Table 5.2.

Various possibilities were explored for selecting the dependent variable. Afterwards descriptive statistics and histograms were produced, and the assumptions for regressions were tested. Since the dependent variable was unknown in 51% of the cases, we checked for a possible selection bias in the database. Afterwards, to obtain a first impression of the validity of the hypotheses, maps of the context variables were produced and they were visually inspected.

Table 5.2. Detailed steps in the data analysis

1	Selecting the dependent variable and producing descriptive statistics
2	Correlation matrix
3	Comparing the project-internal and context variables
4	Differences between technological and social innovations
5	Spatial patterns: country groups, countries, regions and frontrunner regions

The indicator selection process resulted in a longlist of 24 variables. We produced the correlation matrix, which gave us an indication of relevant variables. Afterwards a shortlist of 11 relevant variables was created as input for the regressions. To test the hypotheses, the project-internal and context variables were compared in a regression analysis; we ran binary logistic regressions with various models, with forced entry. The R^2 and the percentage of correct predictions of these models produced indications of the explanatory power of both groups of variables. Furthermore, the significance of two individual variables in combination was checked by analysing the interaction effects. We also tested the differences between technological and social innovations, as we hypothesised that their diffusion has different explaining variables.

Ideally, in answering the research question, frontrunner regions are identified by calculating the scores on the explaining regional context variables and the outcomes are validated with the percentage of transferred innovations per region. However, this is not possible in this research due to the low number of cases per region in the database. As an alternative we chose to analyse the spatial patterns of country groups and individual countries, and to supplement this by an analysis of two combinations of regional indicators, representing two characteristics of innovative regions from the literature: openness and creativeness. The analysis of these combinations may be useful for obtaining a better characterisation of the type of regions acting as frontrunners. Finally, a preliminary index indicator was produced, to gain an impression of individual frontrunner regions.

5.4 Findings

5.4.1 Indicator selection

The various categories of conditions enabling experimentation and diffusion – as described in the mechanisms – were operationalised into indicators (see Table 5.3). We were aiming to cover the various aspects of a condition mentioned in the

mechanism, and for this reason it was often necessary to select more than one indicator for one condition.

The literature shows that most context conditions are localised on the local and regional scale; this corresponds with the scale of a city or a region. It was decided to select indicators preferably with data available on a regional scale (NUTS2, NUTS3 or city scale if available; see Appendix 5.A). Please note that the existing databases were not developed directly for the purpose of this research; therefore, proxies had to be selected for the context conditions derived from the literature.

Table 5.3. Operationalisation of the mechanisms into indicators. For the context conditions it is indicated whether they are expected to enable experimentation or diffusion.

Categories of conditions	Conditions (selected from the mechanism, see Section 5.2)	Indicators	Data source
Project-internal conditions	The technical quality of the innovation	Two indicators: **the duration of the intervention** and **the number of beneficiaries**	Urban Nature Atlas
	The profitability of the innovation	No data available	
	User involvement in the experiment	**User involvement** (this indicator is a combination of two variables from the Urban Nature Atlas: citizen or community groups involvement and citizens or community groups as key actor for the intervention)	
	The competence of the actors involved; distinct skills	**Skill-related methods** (the number of skill-related participatory methods and forms of community involvement used in the intervention)	
	Media attention for the project	**Dissemination of information**	
	Project is led by the government or the university, since they may also enable experimentation and diffusion.	Two indicators: **the project is led by the government** and **the project is led by the university**	

Table 5.3. (continued)

Categories of conditions	Conditions (selected from the mechanism, see Section 5.2)	Indicators	Data source
Counter-cultural milieu	The presence of countercultural movements (experimentation)	Two indicators: **hipster index** (an average score for cities based on the number of vegan eateries, coffee shops, tattoo studios, vintage boutiques, and record stores as % of the population) and **community action for the environment (**regional scale)	Movehub European Value Survey
Local, regional and global sustainability networks	Local and regional sustainability networks enabling social learning based on trust, cultural openness and a shared sustainability ambition (experimentation and diffusion)	Three indicators: **interpersonal trust** (the percentage of the population that strongly agrees with the fact that most people can be trusted, regional scale) and **cultural openness** (cross-cultural contact with people in other countries, regional scale) and **attitudes towards climate change** (an indicator that measures how worried people are about climate change, regional scale).	European Social Survey Eurobarometer European Social Survey
	Local, regional and global sustainability networks enabling diffusion (diffusion)	**City memberships of global sustainability networks**	Own calculation
Vibrant environ-ments	Various forms of temporary proximities, i.e. festivals, conferences and fairs (diffusion)	Two indicators: **international meetings** (no. of corporate, government and NGO meetings in a city per capita) and **international festivals** (no. of international cultural festivals in a city, per capita)	ICCA festivalfinder.eu
Enabling regional actors	Government support, e.g. by giving subsidies, room for experimentation, vision development (experimentation); these factors may also guide the transfer of innovations (diffusion)	Two indicators: **public funding** (the intervention is publicly funded) and **local strategy** (the intervention is developed in response to a local strategy)	Urban Nature Atlas Urban Nature Atlas

Table 5.3. (continued)

Categories of conditions	Conditions (selected from the mechanism, see Section 5.2)	Indicators	Data source
Extra elements: added from literature. They represent charac-teristics of innovative regions, see Section 5.4.8 for a substan-tiation of the choices.	Combined variables representing openness and creativeness. For openness a combination of two dimensions of openness was used. For the social dimension cultural openness and city membership in global sustainability networks was used and for the physical dimension international meetings was used	Combination of indicators: **cultural openness** in combination with **city memberships of global sustainability networks** in combination with **international meetings**	Eurobarometer Own calculation ICCA
	For creativeness, the presence of creatives and their countercultural character are important characteristics	**Core creativity class employment** in combination with **Hipster index**, on a regional/city scale	European regional competitiveness index, Movehub
General indicators	Tertiary education attainment	**Tertiary education attainment**, regional scale	Eurostat
	Regional GDP per capita	**regional GDP per capita**	Eurostat
	R&D expenditure	**R&D expenditure**, regional scale	European regional comp. index
	Population size	**Population size**, regional scale	Eurostat
	Population density	**population density**, regional scale	Eurostat

5.4.2 Data sources

Besides the database of experiments, a large variety of publicly available data sources were used in this research. For a few crucial variables we made our own calculations. We built the indicator selection and the data collection on previous research by two Master's students (Schipper, 2019; Verhagen, 2019). For the context conditions we aimed to collect data on a regional level (NUTS2), but sometimes only more aggregated data were available (see Appendix 5.A).

Missing values

The various data sources sometimes contain a considerable number of missing values (see Appendix 5.B). The dependent variable is not indicated for 51% of the cases, and this is analysed in Section 5.4.9. The project-internal variables have missing values in less than 30% of the cases. Most context variables have missing values in less than 10% of the cases. For some missing values it was possible to

use values on a more aggregate scale (NUTS1 or NUTS0); this is indicated in Appendix 5.A. We decided to exclude variables with a high number of missing values from the regression analysis.

5.4.3 Project-internal conditions

The literature shows that three conditions are the most important for experimentation with innovations: the technical quality of the innovation, user involvement and the competence of the actors. The *technical quality of the innovation* may be an essential element in the diffusion of innovations (Van den Heiligenberg et al., 2017). There was no measure available on the technical quality itself; therefore, two proxies were used: (i) the duration of the intervention, which may indicate a good quality, and (ii) the number of beneficiaries (measured by the number of groups); it was believed that if more groups benefit from the intervention, the quality is better.

User involvement is considered an important factor, especially in a living lab setting (Almirall and Wareham, 2008) where user engagement and user experiences may be used to improve the innovation during experimentation (Van den Heiligenberg et al., 2017). In the data set, user involvement is measured by citizen involvement. We combined two variables to create a new variable with three grades of user involvement: (0) no citizen involvement, (1) citizen involvement and (2) citizens as key actor.

The *competence of the actors* concerns the skills and competences needed for the people involved in experimentation. The database does not contain indicators directly related to the broad category of skills from the literature. The indicator 'skill-related methods used' was used as a proxy. This indicator measures the methods (co-planning, consultation or citizen science) applied in the intervention. Citizen science may be related to the ability to consider complex problems at a high level of abstraction, as mentioned in the literature (Loorbach, 2007).

To these three main indicators, three others were added; these others are indicated as important in the literature, and the dataset offers appropriate data. Project activities aimed at *media attention* are an important factor, since this attention may allow others to start a similar initiative (Loorbach et al., 2020). The dataset contains an indicator which covers this media attention quite well: activities in the project focused on the dissemination of information.

Distinct regional actors, especially *governments* and *universities*, are important in

various ways for the experimentation and diffusion processes. These actors may be involved in the project as project leaders or as regional enablers. Both roles are incorporated in this research. The indicators ‘project is led by the government’ and ‘project is led by the university’ were used as project-internal factors (see also Section 5.4.7), suggesting that acting as a project leader allows these actors to exercise their broader role in supporting the diffusion of innovations. All the indicators for project-internal conditions originate from the Urban Nature Atlas.

5.4.4 Countercultural milieu

Countercultures play an important role in the context of experiments, as they shape a beneficial context for experimentation through alternative ideas and lifestyles (Van den Heiligenberg et al., 2018). There are various options to measure the presence of a countercultural milieu, along the dimensions distinguished by Longhurst (2015): by radical politics (e.g. by using election results for ‘green’ parties), by alternative spiritualities (e.g. by measuring intentional communities such as transition towns or eco-villages) or by lifestyles (e.g. by using data on sustainable food consumption or on buying recycled goods). Another option is to focus on student populations, since alternative movements are often rooted in the ‘1968’ era of protest and conflicts between young activists and state institutions, in Western as well as Eastern Europe. These activists were often students (Klimke and Scharloth, 2008).

We did not find a suitable database with election results, and we decided to reject an indicator for intentional communities, since these communities show a certain level of disconnectedness from mainstream society, which may hamper the adaptation and adoption of these innovations (Evans et al., 2016b).

The presence of Hipster groups is seen by some scholars as an indication of the presence of an innovative urban milieu (Håkansson, 2019). Hipster movements oppose mainstream consumerism (Hubbard, 2016), and they are also associated with biological food and a vegetarian or vegan lifestyle (Maly and Varis, 2015). It was decided to use the indicator ‘Hipster index’ as a proxy. This indicator measures various aspects of alternative lifestyles and consumption in cities. However, it should be noted that we were not able to check the quality of the data, since no scientific information was found on the validity of this indicator or on the measuring method used.

Besides consumption patterns, we wish to address the values of these alternative groups. The presence of these values may be another indication that a

countercultural milieu has been formed, which is regarded as a protective space for fuelling sustainability experiments (Smith and Raven, 2012). The European Value Survey contains an indicator for people belonging to local community action groups. Unfortunately, the dataset shows a high number of missing values. We decided to use a related indicator which has a coverage of 100%: community action for the environment. This indicator measures the part of the population that that belongs to conservation, environmental, ecology or animal rights groups. In addition, an indicator was included for the size of the student population, see Section 5.4.7.

We note that measuring countercultures is problematic; these groups are often small in number and localised in distinct districts in larger metropolitan areas (Van den Heiligenberg et al., 2018). In data on a regional scale, these groups are usually difficult to identify.

5.4.5 Local, regional and global networks

Sustainability networks on various scales are important enablers of experimentation and diffusion, since in these networks learning and knowledge transfer processes take place. In this research two scale levels are differentiated, namely the local & regional scale and the global scale.

On the local and regional scale, sustainability network connections may enable experimentation by facilitating social learning and by the exchange of new ideas (Blok and Tschötschel, 2016; Sengers et al., 2019; Torrens et al., 2019). These learning processes are enabled by for example cultural openness (e.g. by open-mindedness and by an open-source mentality), trust (Boschma, 2005; Sol et al., 2013) and a shared sustainability ambition (Van den Heiligenberg et al., 2022). In the dataset there are no data directly measuring local and regional networks; therefore, data were used that measure the enabling factors of these networks. We selected the indicator cultural openness, which measures cross-cultural contact with people in other countries, and which is also used in other regional innovation research (González-López and Fernández-Montoto, 2017). We did not include an indicator for scientific & technological openness, since this measure is more focused on innovation processes enabled by the cooperation between scientists and firms. An indicator for interpersonal trust was added, in line with other regional innovation scholars (see e.g. Leendertse et al., 2020).

Moreover, a shared sustainability value may facilitate the transfer of innovations, knowledge and ideas in these regional networks and between ‘senders’ and

'receivers' of innovations (Van den Heiligenberg et al., 2022). In this research, an indicator was used that measures people's attitudes towards climate change. These data are available on a regional scale (NUTS1/2); we would have preferred more fine-grained data related to networks, but these were not available.

On the global scale, sustainability networks are mentioned as important carriers of the transfer of sustainability innovations (Castán Broto and Bulkeley, 2013; Williams, 2017). We could not find an aggregate indicator for membership of such networks. Consequently, we created a new indicator, which counts the number of city memberships of seven global and European sustainability networks. We selected networks that discriminate for the cities in this research.

5.4.6 Vibrant environments

Vibrant environments are lively urban spaces, characterised by various places where people meet face-to-face and where they exchange knowledge and innovations (Bathelt et al., 2004; Van den Heiligenberg et al., 2022). Such environments include festivals, conferences and fairs. Unfortunately, data on sustainability festivals or fair-trade fairs were not found. As an alternative, we used more general data for international festivals and international meetings. It was decided to use relative numbers (as a percentage of the population), to correct for the size of the city. However, we also analysed the absolute numbers of festivals. These numbers probably better reflect the size of the groups involved in the transfer of innovations.

5.4.7 Enabling regional actors

In the mechanism it is indicated that the most important regional actors enabling experimentation are the government and the university. For the local and regional government, we used the data from the Urban Nature Atlas for indicators of public funding and of the availability of a local strategy which may guide the experiment. Dignum et al. (2020) found that both indicators are relevant. The government can also enable the experiment by being the project leader; this indicator was included as a project-internal indicator. We did not use an indicator for the quality of government. Although this indicator is often used in regional innovation analyses (Rodrıguez-Pose and Cataldo, 2015), a reference to this indicator in transition studies was not found.

For the role of the university, we considered using indicators for the number of universities, for international university rankings or for the number of (co-)-

publications. Ultimately, we decided to use a measure representing the size of the university, measured by the number of tertiary students enrolled, thus accounting for the broader role a university can play in regional transitions, and for the role many students play as members of a countercultural milieu. Again, relative numbers were used here, to correct for the city size. The university can also enable the experiment by being the project leader; this indicator was included as a project-internal indicator.

5.4.8 Extra elements

For a better characterisation of the regions acting as frontrunners, two combinations of regional indicators were analysed, which represented two characteristics of innovative regions from the literature: openness and creativeness. These concepts stem from RIS research focusing on economic innovation carried out by firms, but there are indications that elements from these concepts are also relevant for sustainability innovations (Van den Heiligenberg et al., 2022).

Openness
A general assumption in the RIS literature is that the diffusion of innovations is enabled by regional and urban openness, meaning greater access to the outside world (Boschma, 2005). Blok and Tschötschel (2016) show that harbour cities can be an assemblage point for local and transnational ideas because of their long-term international orientation. Such cities may have a 'cosmopolitan community' (Beck et al., 2013). It is argued that these conditions enabling the transfer of innovations may also be available in cities and regions that do not host an actual harbour (Torrens et al., 2019; Van den Heiligenberg et al., 2022). The literature shows that a combination of conditions are important for the transfer of innovations; these may concern physical aspects such as international meetings and/or social aspects such as cultural openness (Van den Heiligenberg et al., 2022). Both dimensions were used to select indicators.

Creativeness
In a 'creative city', the 'middleground' is a basic component of the local innovative milieu, where creatives (from the 'underground') and firms (from the 'upperground') meet and interact in creative processes (Cohendet et al., 2010). Florida (2002) demonstrates how a counterculture (the 'bohemians') in this milieu correlates with an underlying openness to innovation and creativity. Indicators were used to measure creatives and countercultural groups.

General indicators
Furthermore, the following general factors were added as they are often used in analyses of regional innovation:

- Tertiary education attainment, assuming that an educated workforce enables the diffusion of knowledge and innovation (Fitjar and Rodríguez-Pose, 2015).
- Regional GDP per capita, assuming that rich city elites may act as frontrunners or early adopters of sustainability innovations (May and Perry, 2016).
- R&D expenditure, suggesting that more knowledge production allows for more innovation (Leendertse et al., 2020).
- Population size, suggesting that larger cities are more innovative because they have a physical concentration of skilled knowledge workers and of the creative class (Florida, 2002; Glaeser, 2011).
- Population density, suggesting that a high density allows for more knowledge transfer (Van Oort, 2002).

5.4.9 Data analysis

Selecting the dependent variable and producing descriptive statistics
In this research, we had various options for selecting the dependent variable. Most regional innovation research uses the number of innovations in a region as the dependent variable; however, we were more interested in the translocal diffusion of innovations, as a contribution to a transition towards a more sustainable system. The Urban Nature Atlas offers various opportunities to measure this translocal diffusion. Data are available for forward transfer (i.e. the innovation is transferred to a successive experiment) as well as backward transfer (i.e. the innovation is based on a previous experiment).

In this research we explored using data for forward and backward transfer, as well as a combination of both. The indicator for forward transfer was selected because it best suits the definition of a frontrunner region used in this research: a forward transfer may be a signal that these experiments act as an inspiring example for others. For robustness reasons, the regression outcomes for forward transfer were compared with forward and/or backward transfer. In this case the dependent variable has two values: either forward or backward transfer or both, or neither forward nor backward transfer.

The model explains forward transfer quite well; this is measured by the explained variance (R^2). In Model 3, see below, the explained variance is 41%. For forward

and/or backward transfer the explained variance is 15%. Backward transfer probably requires other enabling factors, such as the regions' absorptive capacity (Cortinovis and Van Oort, 2019). No data on this topic were available in the database we used in this research.

The statistics were produced and the assumptions for logistic regression were tested (see Appendix 5.B). The missing values in the dependent variable were analysed to check for a possible selection bias. The cases with a missing value are not evenly distributed over Europe (this varies from 19% in Northern Europe to 61% in Western Europe). It was analysed whether the selected cases also vary from the whole dataset (including the non-selected cases) with respect to the independent variables; this would be an indication of a selection bias. For the variables included in the regression differences, less than 10% were found, and often less than 5%. Finally, the selected cases were analysed with respect to the type of innovation (technological, social or system). No large differences in the distribution were found compared to the whole dataset. Thus, the selection bias is probably limited; however, care should be taken in formulating firm conclusions regarding the geographical differences.

To obtain a first impression of the validity of the hypotheses, the maps of the dependent variable and the context variables were visually inspected. For most variables (e.g. for interpersonal trust, see Fig. 5.3), the impression is that high scores are located in Northern and Western Europe. The dependent variable shows a similar pattern: the forward transfer rate is 81% in Northern Europe and 69% in Western Europe, versus 58% in Southern and 47% in Central/Eastern Europe. Contrary to the general patterns, the variable attitudes towards climate change show a very different spatial distribution (see Fig. 5.3). High values in Southern Europe may be related to the severe impact of climate change in these countries (EEA, 2021).

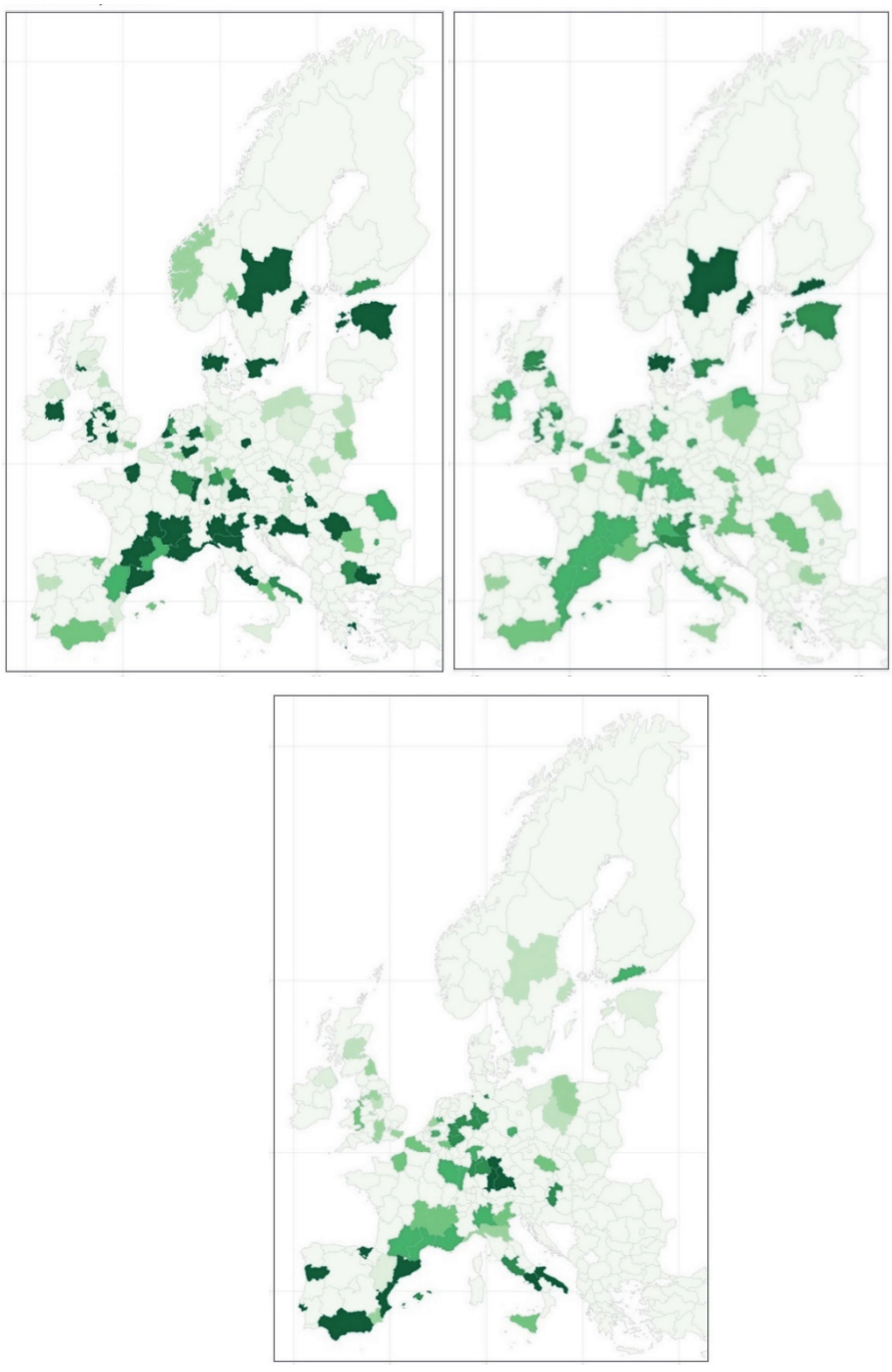

Fig. 5.3. Three distinct spatial patterns in the data sets used: the percentage of transferred innovations (top left), interpersonal trust (top right) and attitudes towards climate change (below).

Correlation matrix

The correlation matrix (see Appendix 5.C) shows that the majority of project-internal and context variables are significantly correlated to the transfer of NBS, such as the number of beneficiaries, the hipster index, community action for the environment, cultural openness, city memberships of global sustainability networks, international meetings, core creativity class employment, tertiary education attainment and regional GDP per capita. Three categories of conditions from the mechanisms show high correlations, namely the 'project-internal conditions', 'countercultural milieu' and the 'local, regional and global sustainability networks'.

What is remarkable is the negative correlation of user involvement. From the literature of living labs, we know that user involvement is helpful to test innovations; it may advance transitions (Almirall and Wareham, 2008; Schliwa and McCormick, 2016). User involvement was analysed in more detail. In the dataset, three grades of user involvement were discriminated (0: no user involvement, 1: citizen involvement, 2: citizens as key actor). For grade 2, the citizens as key actor, the negative correlations were even stronger (correlation coefficient -0.189***). A possible explanation of this high negative correlation is that these innovations have a high grassroots character. We further elaborate on this in Section 5.5.

It may be expected that the dissemination of information contributes directly to the diffusion of nature-based solutions; in fact, this may even be a part of it. Yet, the correlation with the dependent variable is not very high, although still significant. The documentation of the database tells us that these activities relate to the dissemination of information and to education. This variable may be regarded as a factor enabling the potential for diffusion, but it apparently does not always result in actual diffusion of the innovation.

International festivals are not correlated with the transfer of innovations. The festivals in the database were probably not the type of festivals needed for the face-to-face transfer of sustainability innovations as indicated in the literature (Van den Heiligenberg et al., 2022). We further elaborate on this in Section 5.5.

Moreover, the effects of two variables in combination were systematically analysed (with the so-called interaction effects). Several combined variables show significant correlations. Most of these are not surprising because one of the individual variables already shows a significant correlation. There is one exception: the combination of population size and public funding. This combination is positively significant at the < 0.05 level. A possible explanation is that in larger cities the amount of public funding

is larger.

Comparing the project-internal and context variables

To test hypothesis 1, the project-internal and context variables were compared using regression analysis. First, the 'longlist' of variables from the correlation matrix was used to select a shortlist of variables as input for the regressions. We were aiming for a shortlist of four project-internal and four context variables, complemented with three context variables related to characteristics of innovative cities from the literature. The following criteria were used to select the variables as input for the regressions:

- The variables should correlate significantly with the transfer of nature-based solutions.
- To allow testing of the hypotheses, the various elements of the hypotheses should be represented with a variable.
- The variable should have a high number of valid cases.
- For the technical quality of the innovation, the variable ‘number of beneficiaries’ was selected; it shows a more significant correlation than the other variable related to the technical quality, i.e. the duration of the intervention.
- For the context variables, we selected the most significantly correlating variable for every element of the hypotheses. The variables related to the enabling regional actors are not correlated significantly. It was decided to include the variable for public funding in the regressions, so as to be able to better analyse the remarkable negative bivariate correlation that we found in the matrix.

This selection resulted in four project-internal and four context variables, and three optional context variables.

Second, three regressions were carried out (see Appendix 5.D). Model 1 contains the project-internal variables; it is compared with model 2, which contains the context variables. In model 3, all the variables are combined. The project-internal variables only partly explain the transfer of NBS (R^2 = 0.189). The context variables explain a bit more (R^2= 0.231). The combined model correctly predicts 79.8% (R^2= 0.414) of the transfer of NBS, which is quite high. See Appendix 5.D for more details. These results illustrate that the project-internal and context variables complement each other in explaining the transfer.

Differences between technological and social innovations

We hypothesised that the transfer of technological innovations requires other enabling conditions than social innovations. Therefore, both groups were compared on three aspects.

First, the transfer rates were analysed. As shown in Fig. 5.4, social innovations are more successful in their transfer (64%) than technological innovations (53%). This is remarkable. From the literature we learn that technological innovations are more easily transferred, since they use and produce codifiable knowledge (Van den Heiligenberg et al., 2022). From the documentation of the database, we understand that an important share of the social innovations in the database consists of cultural innovations, for instance education and awareness-raising activities. Perhaps the transfer of these innovations is relatively easy.

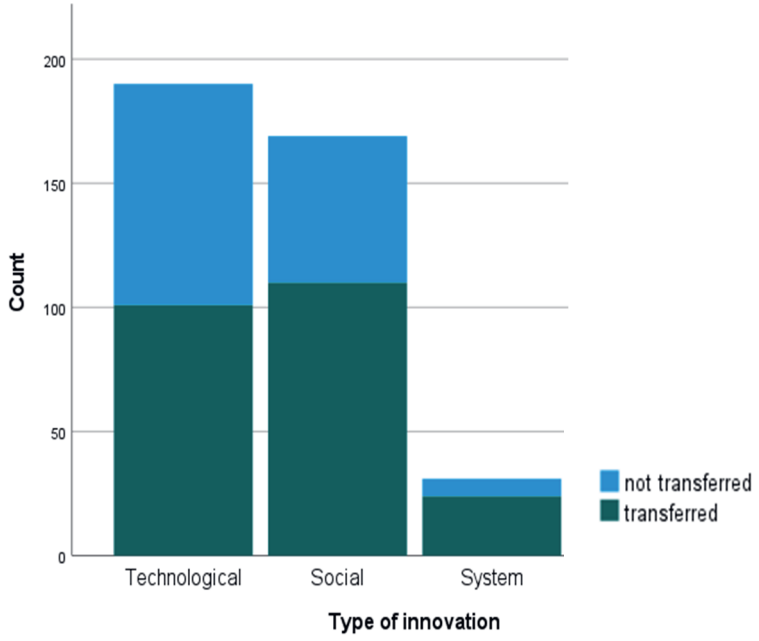

Fig. 5.4. Transfer rates of various types of innovations.

The differences in enabling context conditions were also analysed (see Appendix 5.G). From the literature we know that technological innovations are facilitated more by global networks and social innovations more by local networks, and that these local networks are enabled by trust, cultural openness and a shared sustainability ambition. This difference is partly confirmed by the results. The transfer of

technological innovations is more significantly correlated with the city membership in global sustainability networks, whereas social innovations are significantly correlated with cultural openness. Trust is important for both types of innovations.

Second, differences in the transfer rates were analysed in relation to the duration of the intervention. Figure 5.5 shows that for ‘younger’ interventions (i.e. interventions with a shorter duration) relatively more technological innovations are transferred, and for 'older' interventions relatively more social and system innovations are transferred.

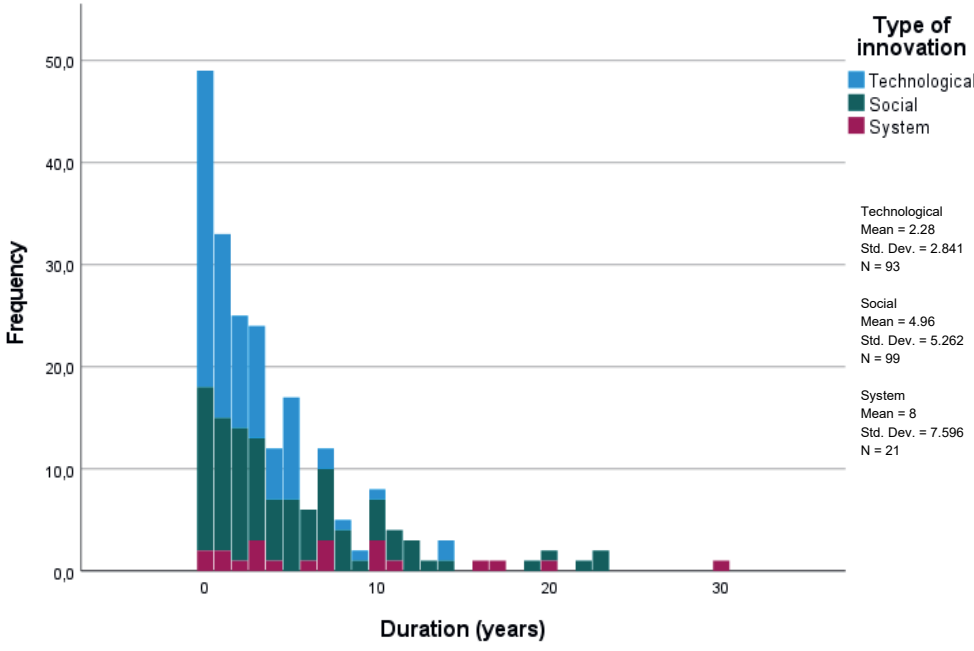

Fig. 5.5. The duration of the intervention for three types of innovation, for transferred innovations only.

Although the literature suggests that technological and social innovations are related (Bulut et al., 2013), no explicit references were found to show that these relationships are time-dependent. From the literature it is also known that technological innovations are more easily transferred (Van den Heiligenberg, 2022). A possible explanation for the differences between younger and older interventions may be that younger interventions have a relatively high novelty level, and that in this case the technological parts of the innovations were transferred. For interventions that are older and have become more mainstream, it is possible that the social and system parts of innovations are also transferred. For a better understanding of these processes, information would be needed about the year the transfer took place.

Unfortunately, this information is not included in the database.

Third, it was investigated whether there is a difference between younger and older innovations in the enabling factors for transfer. The dataset was therefore divided into two groups of about equal size, with a duration of the intervention of more and less than 4 years (see Appendix 5.H). For younger innovations, it is more important to have a high number of beneficiaries, a larger community action for the environment, interpersonal trust, international meetings, more tertiary education attainment, a high regional GDP per capita and a high R&D expenditure. Some of these conditions relate to the emergence of experiments with innovations as found in the literature, such as community action for the environment and interpersonal trust (see Section 5.2.2.1). Unfortunately, it was not possible to run a regression for younger and older innovations separately, due to the low number of cases.

Spatial patterns; country groups, countries, regions and frontrunner regions
For answering the research question, we are interested in the type of regions acting as frontrunner regions for the diffusion of sustainability experiments. Due to the low number of cases per region, a regional analysis has serious limitations. We therefore zoom in from country groups to countries and to types of regions. This method allows us to gain an impression of the spatial patterns of frontrunner regions.

The differences between two *country groups* were tested: Northern and Western Europe versus Southern and Central/Eastern Europe. Some differences could easily be observed by the visual impression of the maps. From general innovation monitors such as the regional innovation scoreboard from the European Union (EC, 2021), higher values were expected in Northern and Western Europe. This pattern is similar to the pattern of transfer rates in the dataset: these rates are 72% in Northern and Western Europe and 52% in Southern and Central/Eastern Europe. Model 3 was compared for both groups of countries (see Appendix 5.E for the results). For Northern and Western Europe, the model correctly predicts the transfer of NBS (83.7%, R^2= 0.408) even better than for Europe as a whole. There is a small but notable difference in the variables explaining the transfer of NBS. In Northern and Western Europe, tertiary education attainment and regional GDP per capita explain the transfer better; however, community action for the environment, interpersonal trust and the absence of public funding explain the transfer better in Southern and Central/Eastern Europe. We do not have an explanation for these differences, but it may be concluded that the model is sensitive for distinct geographical parts of Europe.

Most variables in the regression analysis of country groups show significant positive correlations. Besides user involvement (the complicated role of this variable is discussed in Section 5.5), there are two variables with significant negative correlations, namely public funding (in Southern, Central and Eastern Europe) and regional GDP per capita (in Northern and Western Europe). From the literature, it was expected that *public funding* would enable experimentation and diffusion. In the documentation of the database, it appeared that the majority of NBS are funded by local authorities (Almassy et al., 2018). We suspect that these authorities are mainly interested in enabling the emergence of experiments in their own local territory, and less interested in translocal diffusion. This may explain the negative correlation. Public authorities on a higher scale level, such as the European Union, may be more interested in translocal diffusion. Indications of this mechanism were found in research by Schwanen (2015). *Regional GDP per capita* is also negatively correlated with the diffusion of NBS. In the literature it is proposed that rich city elites may act as frontrunners for sustainability innovations (May and Perry, 2016). In this research, regional GDP per capita is significantly positively correlated in the correlation matrix, but slightly negatively in the regression. Apparently, the contribution of this variable is mixed. It may also be a signal that sustainability innovations are not always carried out by elites. This was also found in research by Håkansson (2019), who found that income-deprived neighbourhoods also show high numbers of sustainability experiments.

To obtain a better impression of the spatial patterns explaining frontrunner regions, we further examined the differences between individual *countries*. The transfer rates were analysed on a country scale and the variables that may explain this transfer were investigated (see Appendix 5.F). The analysis was limited to nine countries with 30 or more experiments in the database. For countries with fewer experiments, the results will probably not be reliable. The highest transfer rates are found in Sweden (100%), France (90%), the Netherlands (78%) and the United Kingdom (74%), and this is in line with the results for country groups.

The results show that the indicator dissemination of information is a common variable explaining the transfer in most countries. It was expected that this variable has large explanatory power, as the dissemination of information may be part of the diffusion itself. However, the overall picture is that different explanations for different countries are observed. Compared to the other countries, the transfer in the UK and Spain depends more on international meetings, in Germany on the number of beneficiaries, in Italy on regional GDP per capita, tertiary education and trust, and in Poland on whether the project is led by a university. Apparently, the model is sensitive to distinct

countries. Moreover, from the national innovation systems literature we learn that there may be a strong contrast in innovation performance between countries; this may be caused by differences in institutional and policy conditions (Freeman, 1995). Some of these conditions may not be covered by the variables in this research. Finally, it should be noted that these findings must be interpreted with care due to the low number of cases in various countries.

For a closer characterisation of favourable types of *regions,* we further examined types of regions. For this, correlations with two combinations of regional indicators were analysed, representing two characteristics of innovative regions from the literature, namely openness and creativeness (see Appendix 5.I).

The combination of variables related to *openness* (international meetings, city membership of global sustainability networks and cultural openness) is highly significant. This is remarkable; apparently this combination covers the enabling conditions quite well. The three variables also show a strongly significant mutual correlation, and they measure the social as well as the physical dimension of openness. The combination of variables related to regional *creativeness* is also significant, but to a lesser extent. These variables are probably especially important for experimentation, and not so much for diffusion.

Finally, to obtain an impression of individual *frontrunner regions* and their geographical distribution over Europe, we constructed an index of frontrunner regions. This is a preliminary index, since it was not possible to validate the outcomes with the actual transfer rates of nature-based solutions, due to the low number of projects for individual regions. The index is presented in Figure 5.6.

The index is a combination of the scores on six context variables. These variables are the same as the ones used in the regression; they are included in the index since they show positive correlations in the regression, most of which are significant. However, the variable for public funding was excluded from the index since it showed no significant positive correlation in the regression or in the correlation matrix. It was decided to keep regional GDP per capita in the index. It showed a slightly negative correlation in the regression, but it correlated significantly positively in the correlation matrix. We may expect that these six variables in combination are the most important spatial context variables explaining the transfer of innovations. Every variable was normalised on a scale of 0 to 1; thus, the index has a hypothetical range of 0 to 6. We had no reasons to apply different weights to the variables. The details of the calculation method can be found in Appendix 5.J.

Within the 89 analysed regions, the frontrunner regions are located mostly in Northern and Western Europe, such as the regions of Noord-Holland, Utrecht and Midland & Eastern Ireland, and also in some isolated hotspots in other parts of Europe, such as Budapest and Catalunya. The top-twelve of frontrunner regions is presented in Table 5.4. What is interesting in this ranking is that most frontrunner regions are characterised by high scores on three recurring variables, namely tertiary education attainment, international meetings and interpersonal trust.

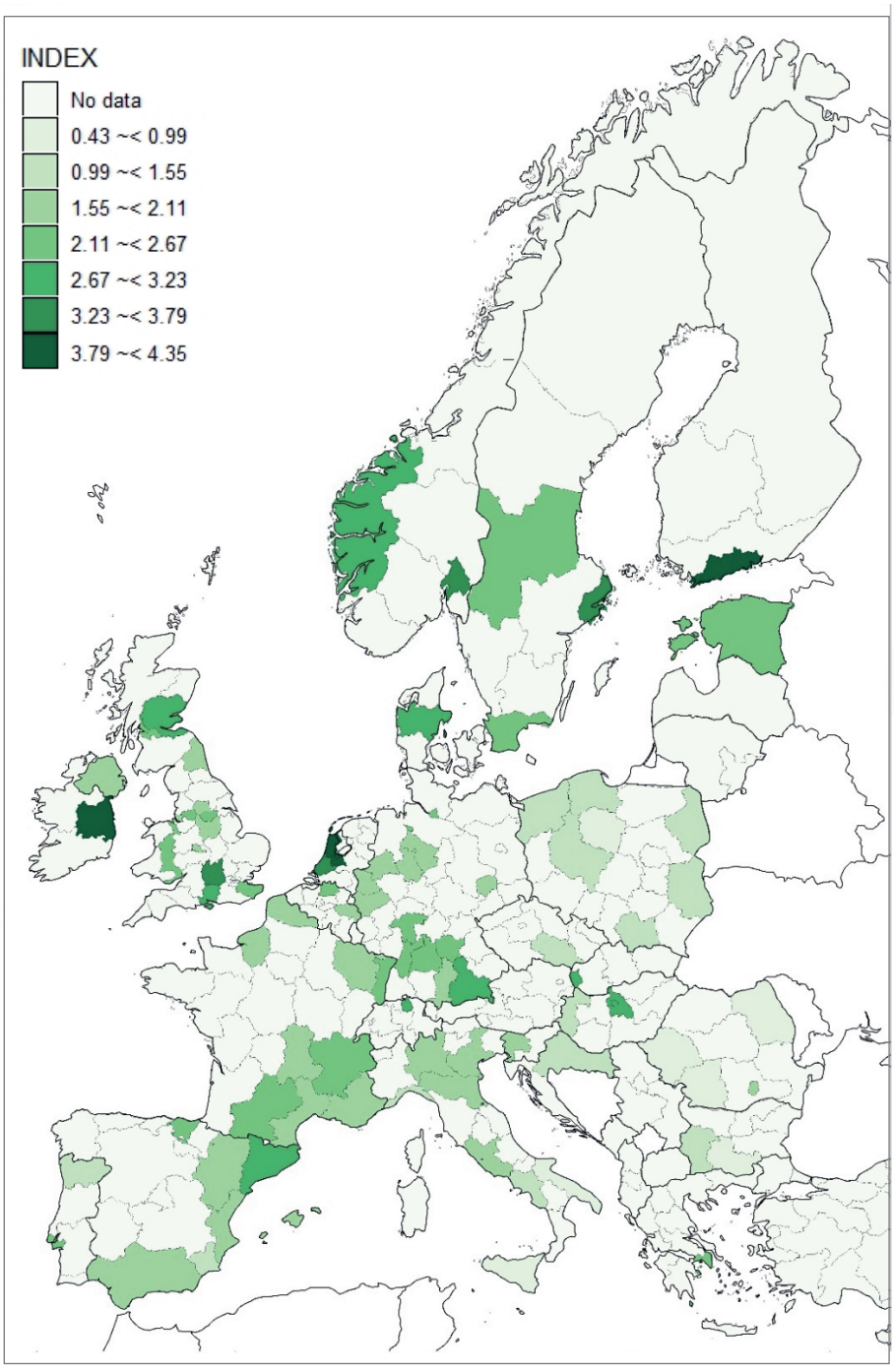

Fig. 5.6. Frontrunner regions (preliminary index).

Table 5.4. The top-12 of frontrunner regions as calculated with the preliminary index. The city included in this research is given in brackets.

Nr.	Region (city)	Score
1	Noord-Holland (Amsterdam)	4.35
2	Utrecht (Utrecht)	4.18
3	Midland and Eastern Ireland (Dublin)	4.14
4	Helsinki-Uusuma (Helsinki)	3.80
5	Stockholm (Stockholm)	3.57
6	Oslo og (Oslo)	3.50
7	Zuid-Holland ('s-Gravenhage)	3.33
8	Berkshire, Buckinghamshire, and Oxfordshire (Reading)	3.31
9	Eastern Scotland (Edinburgh)	3.19
10	Zurich (Zürich)	3.16
11	Catalunya (Barcelona)	3.14
12	Budapest (Budapest)	3.02

5.5 Discussion

Besides the testing of the hypotheses, we have an additional three points for discussion: (i) new insights compared to RIS research, (ii) sorting effects and (iii) the generalisability of the results.

Hypothesis 1 proposes that project-internal as well as local/regional context conditions enable the translocal diffusion of sustainability innovations, and that these two groups complement each other. This is supported by the findings. The regression analysis shows that a combination of project-internal and context factors explains to a large extent the transfer of NBS. This finding is in line what a number of regional innovation systems researchers found. Florida et al. (2017) stated that the key processes that motivate innovation are the products not only of forward-looking individuals and leading-edge firms, but also of cities and urban regions. Cities and regions are thus not merely containers of innovative ideas, but are actively involved in these processes. Camagni and Capello (2017) add a related point by stating that various production factors are ubiquitous (such as capital, codified knowledge and consolidated technologies). However, the ability to organise these factors in innovative processes can be found only in some places, namely in places where tacit knowledge is created and exchanged. We add that these 'places' may even be limited to projects only.

For sustainability innovations it is not yet clear how exactly the project-internal and the context variables work fruitfully in combination. The regression analysis gives a first impression: projects with a large number of beneficiaries, in combination with a vibrant context with a large number of international meetings in a highly educated region may lead to high transfers of innovations.

Hypothesis 2 suggests that that the technical quality of the innovation (H2a), user involvement (H2b) and media attention (H2c) are the most important project-internal factors enabling the transfer of innovations. H2a and H2c are supported whereas H2b is not supported by the findings. This research confirms that the technical quality is an important factor: both proxies measuring the technical quality show significant correlations. We may even suppose that this factor is essential; after all, if the quality is insufficient, the innovation will probably not diffuse. Regarding user involvement, this research sheds new light on the role of users in the diffusion of innovations. It is widely acknowledged that users contribute to the emergence of experiments with innovations in niches (Meelen, 2019). Users shape new routines and enact system change (Schot et al., 2016). User experiences may be used to improve the innovation during experimentation (Van den Heiligenberg et al., 2018). This research shows another picture. User involvement – and especially in the case of a further increase in user involvement, in projects where the citizens are the key actor – is negatively correlated to the transfer of innovations. Apparently, there are limitations to the roles that users play in diffusion. The literature indicates that the communities involved lack resources such as funding, skills and well-defined plans for growth (Hossain, 2016; Meelen, 2019). In addition, these groups are often inwardly oriented (De Moor, 2013).

Hypothesis 3 proposes that frontrunner regions host a countercultural milieu (H3a), a high number of local, regional and global sustainability network connections, supported by trust, cultural openness and shared sustainability values; additionally, it is hypothesised that the diffusion of technological innovations is more enabled by global networks, whereas social innovations may be enabled more by local networks (H3b), a vibrant environment (H3c) and the presence of a few actors enabling experimentation and diffusion (H3d). This hypothesis is almost entirely supported by the findings. The individual sub-hypotheses are discussed below.

Regarding the *countercultural milieu (H3a)*, the countercultural groups are especially relevant for experimentation as they are a constituting element of the habitat. Despite the mostly small-scale character of these groups in districts and neighbourhoods, it was still possible to find significant correlations with two proxies for these groups. It

is problematic to identify the members of these groups; however, this research indicates that members include hipsters and people active in community groups for the environment. However, countercultural groups will probably cover a larger diversity of communities and movements in cities (and also in rural areas), along the dimensions of radical politics, alternative spiritualities and alternative lifestyles (Longhurst, 2015).

Regarding the *sustainability networks (H3b)*, we found that they have a real significance for the experimentation with innovations as well as for their diffusion; they are a constituting dimension of the habitat as well as of the harbour. As hypothesised, we also found some difference between the networks enabling technological innovations versus the networks enabling social innovations. For technological innovations, a significant correlation was found with the city membership of global sustainability networks. Castán Broto and Bulkeley (2013) already noted the role of these networks; however, they only measured three networks and the predictive value of their model was limited. We have measured seven networks and show that this indicator is certainly relevant when explaining the transfer of innovations. On the other hand, social innovations are strongly dependent on local and regional networks. In the dataset there were no data measuring local and regional networks directly; consequently, data were used that measure the enabling factors of these networks. The transfer of social innovations correlates significantly with cultural openness.

Regarding the shared sustainability values, it was expected from the literature to find a correlation with the transfer of innovations, but this was not the case. We frame shared values as part of the similarity concept, assuming that a similarity between sender and receiver may enable the transfer of innovations (McCann, 2016). The indicator used in this research for shared sustainability values measures attitudes towards climate change in the region. We think more fine-grained data are needed on shared values in networks, assuming that sender and receiver often transfer knowledge and innovation in these networks. These data are currently not available.

With respect to *vibrant environments (H3c),* we find that international meetings are highly significant in explaining the diffusion of innovations; these are a constituting dimension of the harbour. This finding underlines the importance of temporary proximities such as meetings, conferences and fairs where face-to-face contact helps in the exchange of knowledge and innovations (Van den Heiligenberg et al., 2022). Festivals have a similar role, although in this research they are not correlated with the transfer of innovations. The dataset of this research covers cultural festivals.

For example, 50% of the category 'musical festivals' in the dataset relates to classical music festivals. The majority of festivals in the database are probably focused on other target groups than the groups involved in sustainability experimentation. Moreover, the typical sustainability festivals focusing on the exchange of practical initiatives and solutions for sustainability (such as the Alternatiba festivals in France) are not included in the database.

Regarding the *enabling regional actors (H3d)*, we find that the university is an important facilitator of the diffusion of innovations; it is a constituting dimension of the harbour. The literature illustrates this by showing that universities are not only important as gatekeepers enabling the diffusion of knowledge (Kauffeld-Monz and Fritsch, 2013), but that they are also important in a much broader sense in knowledge exchange and learning processes (Van den Heiligenberg et al., 2022).

Overall, regarding hypothesis H3, this research suggests that for frontrunner regions it is important to have a combination of various context conditions. We find significant correlations for conditions related to cities characterised by a combination of social and physical openness. However, the regression results show that other indicators may be additionally important, such as a countercultural milieu and trust-based relationships in sustainability networks.

New insights

An important point of discussion is whether this research sheds additional light on the spatial conditions for the diffusion of innovations, compared with what is already known from the RIS literature. This question is related to possible differences between sustainability innovations and economic innovations. Although the differences between both groups are not clearly indicated, we find some indications in the literature that the diffusion mechanisms differ. The diffusion of economic innovations is fuelled when there is a market pull, and when these innovations offer a potential advantage for the user (Rogers, 2003). As such, general innovation research and RIS research generally do not address questions of transition, i.e. how experimentation and diffusion may contribute to system change. Such research has not yet taken into account that for the sustainability challenge, systems have to be transformed towards a societal goal. This intentionality may result in innovations that will not be taken up by the market, in user behaviour that needs to be adapted or in public demand that is lacking (Asheim et al., 2016). These aspects may seriously hamper the diffusion of sustainability innovations, and these barriers may require other enabling conditions.

Compared to RIS research, this research offers some new insights, namely into the complicated role of user involvement, the role of countercultural movements, the importance of city memberships of global sustainability networks and the possible role of a shared sustainability ambition (although in this research the latter was found to be not significant). Moreover, sustainability innovations have been developed and tested by a large variety of actors, including grassroots groups. The innovations developed by these groups may be strongly embedded in local and regional contexts, which may make them less footloose than some economic innovations (Binz and Truffer, 2017). This also relates to the next point of discussion.

Sorting effects

In this research large differences have been found in enabling conditions for diffusion between regions. A relevant question is where these differences originate from; in other words, is their origin people-based or place-based (Neumark and Simpson, 2015)? In the case of this research, it is relevant to ask ourselves whether the differences between the enabling conditions in regions are the result of flexible dynamic sorting processes of people, firms and other actors, or the result of long-term path-dependent development processes in the region that are strongly embedded in the local culture and institutions?

Sorting processes are studied in economic geography research (Van Oort, 2018). This literature demonstrates that innovative companies may be attracted to economically ‘dense’ areas, and therefore move (and sort) towards these locations.

On the other hand, from the literature of the geography of transitions we learn that sustainability innovations, and more specifically social innovations for sustainability, can be strongly embedded in local contexts (Binz and Truffer, 2017; Van den Heiligenberg et al., 2022). In the literature some examples are known, such as the Transition Towns (Longhurst, 2015), sustainability initiatives in Karlsruhe (Van den Heiligenberg et al., 2018) and food-sharing cities (Davies et al., 2017), which show that the high density of experiments can be explained by a long-term co-evolutionary development of experiments and context over several decades. These examples point towards place-based conditions.

In this research we found four main conditions enabling diffusion: a countercultural milieu, sustainability networks, vibrant environments and enabling regional actors. The question is whether these conditions are the result of sorting processes. The presence of a *countercultural milieu* may be people-based or place-based. In the literature, it is indicated that these alternative movements are related to student

populations (Klimke & Scharloth, 2008). High concentrations of students may be interpreted as the result of a sorting process; on the other hand, it is conceivable that these people will become part of an alternative movement only when this is present in a university city. The presence of effective *sustainability networks* may be partly the result of sorting. The cities in this research may attract people with high trust and cultural openness, which are important cultural conditions for effective networks.

The other main conditions enabling diffusion in this research are the presence of vibrant environments (such as festivals, conferences and fairs) and of enabling regional actors (the government and the university). These conditions probably have a more place-based character. Furthermore, the regional actors are important for their roles and activities, and not directly for the properties or skills of their employees.

We conclude that there are indications that sorting processes are relevant for the sustainability innovations in this research, but probably to a lesser extent than for economic innovations in firms, as indicated in economic geography research.

Generalisability of the results

It was not easy to find a suitable dataset for this study. The selected Urban Nature Atlas has some advantages, but it also has some properties that may affect the generalisability of the results. The dataset has a large variety of experiment types (both technological and social innovations, and both guided and grassroots experiments). This makes some generalisation of the results possible. The total number of cases is acceptable (N=472), but unfortunately the number of cases per region did not allow for a detailed analysis of individual regions. The question is also whether we are dealing with innovations in all the cases. The database indicates that one third of the innovations is not based on a previous project, suggesting that these projects are innovative projects that are new to the world. However, projects based on previous projects may also be innovative, albeit not so much new to the world but new to the region (Binz and Gong, 2021).

The dataset almost exclusively includes university cities; as a result, it was not possible to compare university cities with non-university cities, which is probably a relevant distinction in the research on the diffusion of innovations. Consequently, we think that the results with regard to universities and students should be treated with care. This also holds for the results on countercultures, which may be related to student populations. The missing values with regard to the transfer of innovations are spatially unevenly distributed across Europe, which means that statements about

spatial distributions must also be interpreted with some care. Finally, the logistic regression assumptions test did not give any cause for concern, meaning that the regression results are generalisable to a larger population.

5.6 Conclusion

In this study we address the following research question: which project-internal and spatial context conditions enable the translocal diffusion of sustainability innovations in Europe, and which type of regions in Europe are frontrunners in this? The main finding in this research is that to a large extent, a combination of project-internal and context factors explains the transfer of sustainability innovations; the two groups of factors complement each other. Relevant project-internal conditions are the technical quality of the innovation and the project activities aimed at media attention. The most important local and regional context conditions are a countercultural milieu, sustainability networks enabled by trust and openness, vibrant environments (in particular international meetings) and enabling regional actors (in particular the university). Overall, frontrunner regions are characterised by physical as well as social openness, and are mainly found in Northern and Western Europe.

This research addresses gaps in our understanding of systematic patterns in the geographical uneven diffusion of sustainability innovations in Europe. In combination with existing literature, the results from this research give a more robust picture of the most important project-internal and context conditions. Conceptually, we contribute to a better analysis of the diffusion of sustainability elements by arguing that (i) project-internal and context factors have to be analysed in combination and (ii) the enabling conditions for experimentation have to be included, as these factors illustrate that it is already possible to anticipate a future diffusion during experimentation.

This study provides some relevant insights for local and regional stakeholders. In the current time frame, many local and regional governments embrace a ‘governance by experimentation’ approach (Bulkeley and Castán Broto, 2013). The stakeholders involved have many questions about which support is needed for the translocal diffusion of the innovations in their city or region. The interesting finding for these stakeholders is that the key factors for this support are to be found in the context conditions on the local and regional scale (but only if some project-internal conditions are also met). We conclude that the context matters. In these local and regional contexts, the stakeholders may improve some of the conditions. For instance, countercultural groups can be valued as groups that are important for

experimentation with innovations. Sustainability networks and vibrant environments can be created or can focus better on the diffusion of innovations. Finally, it is clear that the universities and the government can be actively involved in the diffusion of sustainability innovations in various ways. However, we have to remark that this study also shows that what works for one country may not work for another; in other words, tailor-made solutions are needed.

We have two suggestions for further research. First, we propose to better unravel whether experimentation with sustainability innovations requires a different context than their diffusion. From this research it has become clear that the enabling contexts (the habitat and the harbour) partly overlap, especially regarding networks. However, there are also differences in the enabling contexts, such as the presence of a countercultural movement that enables experimentation and a vibrant environment that enables diffusion. These differences can also be traced back to possible differences in underlying theories. In the literature of transition studies it is supposed that nurturing in a protective space is a condition for experimentation (Smith and Raven, 2012). This suggests – temporary – isolation, while in the regional innovation system theory openness is considered a condition for diffusion (Boschma, 2005; Iammarino and McCann, 2013).

Second, we wish to recommend future research into the possible emergence of a shared value pattern with regard to sustainability in European cities. In this, we are not referring so much to all groups in society, but rather to the shared values between countercultural groups in cities worldwide. This topic requires fine-grained value research, including research in the international networks of which these groups are often a member. Such research can be of great significance for the acceleration of sustainability transitions in future.

Acknowledgments

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Appendices

Appendix 5.A Indicators

Table 5.A. Overview of indicator data sources

Category of conditions	Indicator	Measurement	Database	Geographical level	Year
Project-internal conditions	The duration of the intervention	Duration in years, calculated by the year the implementation process ended minus the starting year of the implementation process. Ongoing interventions set to having ended in 2018, assuming that they would last at least one year after data collection.	Urban Nature Atlas	project	2017
	The number of beneficiaries	Number of beneficiaries (scale 0-9) of the intervention (e.g. government, private sector, citizens).			
	User involvement	We created a new ordinal variable, based on two existing variables: 0= no citizens or community group involvement. 1= citizens or community group involvement 2= citizens or community groups as key actor			
	Skill-related methods	The number (scale 0-3) of skill-related participatory methods and community involvement (co-planning, consultation and citizen science).			
	Dissemination of information	Activities concerning the dissemination of information and education, binary variable.			
	Project is led by the government	The intervention is government-led, binary variable.			
	Project is led by the university	The intervention has researchers/university as key actor, binary variable.			
Counter-cultural milieu	Hipster index	Average score based on the number of vegan eateries, coffee shops, tattoo studios, vintage boutiques and record stores per 100,000 inhabitants.	Movehub	City	2018

Table 5.A. (continued)

Category of conditions	Indicator	Measurement	Database	Geographical level	Year
	Community action for the environment	% of people that belong to conservation, environmental, ecology or animal rights groups.	European Value Survey	NUTS1 missing values: NUTS0	2008
Sustainability networks	Interpersonal trust	Weighted average score (0-10) on question: 'Most people can be trusted or you can't be too careful?'.	European Social Survey	NUTS1/ 2/3	2008-2016
	Cultural openness	% of the population that confirmed the statement "Your job involves contact with organisations or people in other countries".	Eurobaro meter 67.1	NUTS1/ 2	2007
	Attitudes towards climate change	Weighted average score (1-5) on the question "how worried are you about climate change?".	European Social Survey	NUTS2 (Germany, France, UK NUTS1)	2016
	City memberships of global sustainability networks	Number of memberships (score 0-7) of global and European intercity sustainability networks (ICLEI, C40, Eurocities, Convenant of Mayors, Energy Cities, Resilient Cities and European Green Capital Cities).	Own calculation, based on websites of the seven networks	City	2021
Vibrant environments	International meetings	No. of corporate, government and NGO meetings in a city per capita. Missing values changed to null, since ICCA claims that their database covers 80% of the meetings.	ICCA; (retrieved from website in April 2019, data from Schipper, 2019)	City	2019
	International festivals	No. of international cultural festivals organised between 1-1-2015 and 1-4-2021 per city, per capita.	Own calculation, using data from festivalfinder.eu and population size	City and NUTS2	2015-2021 2015-2017
Enabling regional actors	Public funding	The intervention is publicly funded, binary variable.	Urban Nature Atlas		

Table 5.A. (continued)

Category of conditions	Indicator	Measurement	Database	Geographical level	Year
	Local strategy	The intervention is developed in response to a local strategy, binary variable.	Urban Nature Atlas		
	Tertiary students	Number of tertiary students enrolled as % of the population.	Own calculation, based on Eurostat	NUTS1/2	2015 (N. Ireland 2018)
Extra elements	Combination of cultural openness, city memberships of global sustainability networks and international meetings	See above			
	Combination of core creativity class employment and Hipster index	Core creativity class employment Hipster index: see above	European regional competetiveness Index 2019	NUTS2	2015-2017
	Tertiary education attainment	% of people with tertiary education attainment (ISCED level 5-8)	Eurostat	NUTS2	2019
	Regional GDP per capita	Regional GDP per capita in PPS	European regional competitiveness Index 2019	NUTS2	2015-2017
	R&D expenditure	Total R&D expenditure as % of the GDP	European regional competitiveness Index 2016	NUTS2	2012-2013
	Population size	Population size	Eurostat	NUTS3	2015
	Population density	Population density	Eurostat	NUTS3	2018-2019

Appendix 5.B Descriptive statistics

Table 5.B. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. deviation
Transfer forward in time	472	0	1	0.63	0.484
User involvement	967	0	2	0.83	0.712
Duration of the intervention (lg)	804	0.00	1.49	0.55	0.37
Number of beneficiaries	965	1	7	2.14	1.03
Skill-related methods	704	0	3	0.81	0.75
Dissemination of information	704	0	1	0.53	0.50
Project is led by government	967	0	1	0.28	0.45
Project is led by university	967	0	1	0.22	0.42
Hipster index	620	2,611	69,437	32,654	16,107
Community action for the environment (lg)	967	0.00	1.59	0.52	0.35
Interpersonal trust	938	1.49	7.04	4.83	0.85
City membership in global sustainability networks	967	0	7	2.33	1.50
Local strategy	651	0	1	0.87	0.34
Public funding	893	0	1	0.80	0.40
Cultural openness	929	0.00	28.00	9.54	6.47
Attitudes towards climate change	872	2.71	3.62	3.19	0.23
International meetings (lg)	967	0.00	2.29	0.86	0.74
International festivals (lg)	967	0.00	0.41	0.08	0.10
Tertiary students	967	0.0147	0.1118	0.0406	0.0133
Core creativity class employment	928	4.59	20.52	10.74	3.47
Tertiary education attainment	947	11.7	54.3	35.15	10.19
Regional GDP per capita	928	33.69	204.77	99.43	33.98
R&D expenditure as % of GDP	967	0.16	6.00	1.76	1.08
Population size	928	633,449	10,010,043	2,865,031	1,904,962
Population density	967	15	10,446	1,440	1,702
Valid N (listwise)	124				

Test for the assumptions for logistic regression

Following Field (2009) the following assumptions were tested:

- Linearity between independent and dependent variable, by checking significant

correlations between (i) the interaction term between a continuous variable and its natural logarithm and (ii) the dependent variable. Significant correlations were found for interpersonal trust and international meetings, but this gave no cause for concern.

- Independence of errors. No relationships between the cases are observed. Spatial autocorrelation is not applicable, as the cities are mostly not adjacent.
- Equality of variance. The VIF scores were calculated for the variables in the regression; they are all between 1 and 3 and gave no cause for concern.
- Multicollinearity. The variable core creativity class employment shows high correlations (multicollinearity) with the variables tertiary education attainment and cultural openness. This variable was excluded from the regressions.
- Normal distribution: for 4 variables with a positive skew, we applied a log transformation.

Appendix 5.C Correlation matrix

Table 5.C. Correlation matrix

		Transfer forward	1	2	3	4	5	6	7	8
1	User involvement	-.141**								
2	Duration of the intervention (lg)	.109*	-.016							
3	Number of beneficiaries	.256***	.034	.109**						
4	Skill-related methods	-.134*	.375***	.030	-.024					
5	Dissemination of information	.116*	.013	.105*	.119**	-.052				
6	Project is led by government	-.066	-.185***	.058	-.063	-.094*	.026			
7	Project is led by university	.113*	-.078*	.046	.182***	-.036	.086*	-.115***		
8	Hipster index	.239***	-.009	.047	.070	.044	-.059	-.010	.015	
9	Community action for the environment	.324***	-.095**	.218***	.130***	-.009	-.005	-.052	.056	.277***
10	Interpersonal trust	.345***	-.031	.225***	.121***	-.054	-.015	-.023	.018	.497***
11	Cultural openness	.251***	-.026	.181***	.139***	.101**	-.084*	-.097**	.035	.404***
12	Att. towards climate change	-.036	-.061	.065	.001	-.041	.265***	.205***	-.047	-.113**
13	City membership global sustainability networks	.208***	-.126***	.130***	-.018	-.065	.008	.056	.048	.173**
14	International meetings (lg)	.175***	-.105**	.084*	-.010	-.038	-.036	-.020	.084**	.240***
15	International festivals (lg)	.064	-.099**	-.025	-.094**	-.106**	.020	-.009	.025	.097*
16	Public funding	-.081	.030	.154***	-.039	.067	-.003	.273***	-.013	-.096*
17	Local strategy	-.160**	-.068	.071	-.030	.005	-.187***	.190***	-.005	-.013
18	Tertiary students	.010	.032	.011	-.075*	-.002	-.039	-.043	.027	.152***
21	Core creativity class employment	.268***	-.045	.110**	.084*	.061	-.075	-.098**	.026	.444***
20	Tertiary education att.	.223***	.058	.029	.101**	-.008	-.115**	-.087**	.023	.403***
19	Regional GDP per capita	.256***	-.091**	.121**	.021	-.027	.189**	.005	.004	.116**
22	R&D exp. as % of GDP	.224***	-.056	.181***	.049	.058	.130**	-.036	.022	.275***
23	Population size	.040	-.002	.042	.008	-.032	.156***	.044	-.013	-.175***
24	Population density	-.020	.021	.036	-.018	.098**	-.035	-.065*	-.074*	.190***

Table 5.C. (continued)

		9	10	11	12	13	14	15	16
1	User involvement								
2	Duration of the intervention (lg)								
3	Number of beneficiaries								
4	Skill-related methods								
5	Dissemination of information								
6	Project is led by government								
7	Project is led by university								
8	Hipster index								
9	Community action for the environment								
10	Interpersonal trust	.517***							
11	Cultural openness	.655***	.652***						
12	Att. towards climate change	-.102**	-.132***	-.281***					
13	City membership global sustainability networks	.155***	.285***	.105**	.176***				
14	International meetings (lg)	.091**	.231***	.108**	.130***	.592***			
15	International festivals (lg)	-.042	-.039	-.095**	-.041	.379***	.480***		
16	Public funding	.010	.031	-.036	.035	.013	-.007	.009	
17	Local strategy	-.004	.017	.001	-.137**	-.068	-.026	-.059	.429***
18	Tertiary students	.089**	.098**	.180***	-.153***	.340***	.294***	.304***	.011
21	Core creativity class employment	.533***	.570***	.703***	-.253***	.233***	.228***	.152***	-.065
20	Tertiary education att.	.385***	.432***	.501***	-.371***	.200***	.219***	.148***	-.073*
19	Regional GDP per capita	.350***	.597***	.493***	.207***	.436***	.322***	.191***	.001
22	R&D exp. as % of GDP	.523***	.569***	.498***	.181***	.359***	.192***	.112***	.003
23	Population size	-.104**	-.131***	-.275***	.407***	.137***	.250***	-.159***	-.008
24	Population density	.081*	.263***	.347***	-.053	.075*	.228***	-.040	-.161***

Table 5.C. (continued)

		17	18	19	20	21	22	23
1	User involvement							
2	Duration of the intervention (lg)							
3	Number of beneficiaries							
4	Skill-related methods							
5	Dissemination of information							
6	Project is led by government							
7	Project is led by university							
8	Hipster index							
9	Community action for the environment							
10	Interpersonal trust							
11	Cultural openness							
12	Attitudes towards climate change							
13	City membership global sustainability networks							
14	international meetings (lg)							
15	International festivals (lg)							
16	Public funding							
17	Local strategy							
18	Tertiary students	-.043						
19	Core creativity class employment	.014	.462***					
20	Tertiary education attainment	.096*	.574***	.763***				
21	Regional GDP per capita	-.005	.311***	.630***	.415***			
22	R&D expenditure as % of GDP	-.019	.316***	.617***	.485***	.689***		
23	Population size	-.095*	-.091**	-.293***	-.236***	-.018	-.025	
24	Population density	-.109**	.113***	.462***	.183***	.331***	.168***	.172***

Note: *p < 0.05; **p < 0.01; ***p<0.001

Appendix 5.D Regressions

Table 5.D. Binary logistic regressions for project-internal variables (Model 1), for context variables (Model 2) and for both (Model 3). Dependent variable: forward transfer of nature-based solutions.

Regression	Model 1	Model 2	Model 3
Project-internal variables			
user involvement			
user involvement(1)	-1.098*** (0.371)		-1.188*** (0.450)
user involvement(2)	-1.631**** (0.392)		-1.919**** (0.510)
Number of beneficiaries	0.594**** (0.145)		0.542*** (0.183)
Dissemination of information(1)	0.572** (0.255)		0.734** (0.329)
Project is led by university(1)	0.039 (0.319)		0.263 (0.410)
Context variables			
Community action for the environment (lg)		1.093** (0.487)	0.566 (0.579)
Interpersonal trust		0.627*** (0.185)	0.624** (0.250)
International meetings (lg)		0.391** (0.174)	0.763*** (0.238)
Public funding(1)		-0.591** (0.293)	-1.209*** (0.464)
Optional context variables			
Tertiary education attainment		0.025* (0.014)	0.056*** (0.020)
Regional GDP per capita		-0.010* (0.005)	-0.024*** (0.008)
R&D expenditure		0.069 (0.165)	0.061 (0.244)
Constant	0.384	-2.691**** (0.735)	-1.965** (1.094)
-2log likelihood	379.281	446.11	267.57
Nagelkerke's R^2	0.189	0.231	0.414
Percentage correct predictions	73.9	72.2	79.8
N	353	399	307

Standard errors in brackets; one-tailed tests
*p< 0.1, **p< 0.05, ***p< 0.01, ****p<0.001

Appendix 5.E Differences between country groups

Table 5.E. Binary logistic regressions for Northern & Western Europe (Model 3A) and for Southern & Central/Eastern Europe (Model 3B). Dependent variable: forward transfer of nature-based solutions. For country groups the geographical subregions of Eurovoc are used (EUROVOC, 2021).

Regression	Model 3A	Model 3B
Project-internal variables		
User involvement		
User involvement (1)	-1.459** (0.740)	-1.069* (0.631)
User involvement (2)	-1.982** (0.841)	-1.380* (0.741)
Number of beneficiaries	0.697** (0.283)	0.388 (0.273)
Dissemination of information (1)	0.545 (0.549)	0.549 (0.487)
Project is led by university (1)	0.008 (0.647)	0.438 (0.574)
Context variables		
Community action for the environment (lg)	-0.066 (0.842)	2.961* (1.763)
Interpersonal trust	0.492 (0.672)	0.819** (0.361)
International meetings (lg)	0.634 (0.428)	0.573 (0.371)
Public funding (1)	-0.168 (0.579	-2.843** (1.138)
Optional context variables		
Tertiary education attainment	0.093** (0.039)	0.027 (0.034)
Regional GDP per capita	-0.035*** (0.012)	-0.002 (0.018)
R&D expenditure	0.337 (0.333)	-0.711 (0.631)
Constant	-2.294 (3.258)	-1.731 (1.537)
-2log likelihood	130.252	119.918
Nagelkerke's R^2	0.408	0.466
Percentage correct predictions	83.7	79.8
N	178	129

Standard errors in brackets; one-tailed tests
*p< 0.1, **p< 0.05, ***p< 0.01, ****p<0.001

Appendix 5.F Differences between countries

Table 5.F. Bivariate correlations with the dependent variable for 9 countries, and transfer rates (the percentage of successful forward transfer of nature-based solutions).

	NL	UK	DE	FR	ES	IT	PL	RO	SE
User involvement	0.243	-0.007	-.276*	0.090	-0.004	-0.245	-0.051	-0.079	0.150
Number of beneficiaries	0.067	.305**	.480***	0.029	0.267	-0.151	0.065	-0.045	0.106
Dissemination of information	.567**	.287*	-0.151	-0.123	0.052	.401**	.441*	-0.408	0.040
Project is led by university	0.073	0.083	.281*	0.228	0.203	0.160	.422**	-.444*	0.139
Community action for the environment (lg)		0.017	0.086	0.052		.461**		-0.207	0.139
Interpersonal trust	-0.379	0.218	-0.077	-0.185	0.142	.768***	0.178	0.185	-0.013
International meetings (lg)	0.110	.392**	0.090	-0.117	.293*	.562***	-0.068	-0.037	-0.254
Public funding	-0.163	-0.028	-0.259	0.088	-0.179	-0.248	0.171	0.174	
Tertiary students	-0.379	-0.227	-0.196	-0.062	-0.011	0.144	0.022	0.185	0.013
Tertiary education attainment	-0.379	-0.007	0.184	0.185	-0.071	.779***	0.154	0.126	-0.254
Regional GDP per capita	-0.480	.319**	-0.042	0.309	-0.060	.790***	-0.057	0.126	-0.254
R&D expenditure as % of GDP	-0.110	0.080	0.147	0.172	0.192	.543***	0.105	-0.037	-0.254
N	23	74	51	29	52	52	52	23	27
Transfer rate	78%	74%	45%	90%	55%	64%	17%	70%	100%

Note: *p < 0.05; **p < 0.01; ***p<0.001

Empty cells: correlation could not be calculated

Appendix 5.G Differences between technological and social innovations

Table 5.G. Bivariate correlations with the dependent variable for technological and social innovations.

	Technological innovations	Social innovations
Duration of the intervention (lg)	-0.097	.222**
Number of beneficiaries	.226**	.225**
User involvement	-.279***	-0.140
Skill-related methods	-.334***	-0.037
Dissemination of information	0.030	.239**
Project is led by government	-0.075	-0.013
Project is led by university	0.059	.164*
Hipster index	0.103	.401***
Community action for the environment (lg)	.262***	.302***
Interpersonal trust	.283***	.307***
Cultural openness	0.128	.204**
Attitudes towards climate change	-0.021	-0.025
City membership in global sustainability networks	.217**	.152*
International meetings (lg)	.209**	.193*
International festivals (lg)	.163*	0.063
Public funding	-0.114	-0.147
Local strategy	-0.154	-.218*
Tertiary students	-0.035	0.087
Core creativity class employment	.170*	.287***
Tertiary education attainment	.166*	.265**
Regional GDP per capita	.206**	.224**
R&D expenditure as % of GDP	.164*	.253**
Population size	0.105	-0.029
Population density	-0.042	-0.022
N	190	169

Note: *p < 0.05; **p < 0.01; ***p<0.001

Appendix 5.H Differences between younger and older innovations

Table 5.H. Bivariate correlations with the dependent variable for nature-based solutions with a duration of the intervention of less and more than 4 years.

	duration < 4 years	duration >= 4 years
User involvement	-.180**	-0.121
Number of beneficiaries	.304***	0.098
Dissemination of information	0.036	0.097
Project is led by university	.120*	0.097
Community action for the environment (lg)	.362***	.195*
Interpersonal trust	.407***	0.141
International meetings (lg)	.179**	0.076
Public funding	-.177**	0.073
Tertiary students	-0.007	-0.006
Tertiary education attainment	.332***	-0.013
Regional GDP per capita	.299***	0.022
R&D expenditure as % of GDP	.266***	-0.017
N	269	146

Note: *p < 0.05; **p < 0.01; ***p<0.001

Appendix 5.I Relation with concepts of innovative regions

Table 5.I. Correlations (i.e. interaction effects) for combined variables related to openness and creativeness. Dependent variable: forward transfer of nature-based solutions. For simplicity reasons, all variables have been converted to a binary version (below or above the mean value). Baseline = last.

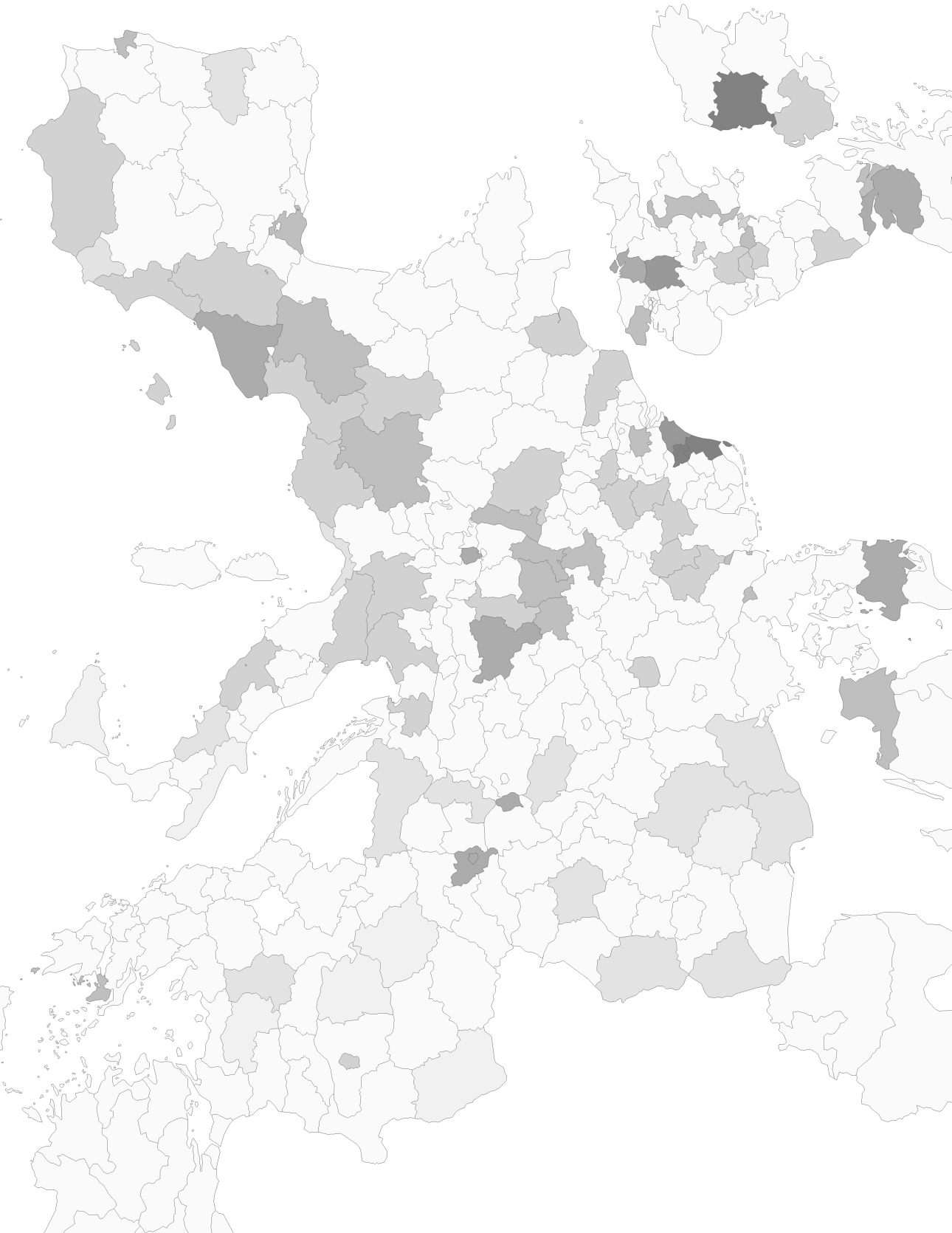
Variables related to openness	
International meetings binary(1)	-1.126*** (0.301)
City membership in global sustainability networks binary(1)	0.330 (0.308)
Cultural openness binary(1)	-0.224 (0.309)
International meetings binary(1) by City membership in global sustainability networks binary(1) by Cultural openness binary(1)	-1.021* (0.402)
Constant	1.675 (0.206)
N=472	
Variables related to creativeness	
Hipster index binary(1)	-0.177 (0.290)
Core creativity class employment binary(1)	0.059 (0.410)
Core creativity class employment binary(1) by Hipster index binary(1)	-0.974* (0.476)
Constant	1.039*** (0.216)
N=472	

Note: *p < 0.05; **p < 0.01; ***p<0.001

Appendix 5.J Calculation frontrunner index

For calculating the index, the same context variables were used as were used in the regression. The variable for public funding was excluded.
Detailed steps were:

1. To avoid missing values, for some regions in Poland the national averages were used, for the variables Regional GDP per capita, Tertiary education attainment. For non-EU countries in the database (Norway, Switzerland), OECD data was used for Regional GDP per capita and Interpersonal trust.
2. The data was normalised in order to get equal weights in the index; this resulted in a range from 0-1 per variable.
3. The 6 variables were totalised to calculate the index.



Chapter 6

Conclusions & discussion

6.1 Introduction

The urgency of the global sustainability challenge requires a fundamental system change; that is, a transition of the systems, for example, for the provision of energy, food and mobility.

The transition studies literature suggests that a fundamental system change can start small in practice-based experiments with innovations mostly in local contexts (Hansen and Coenen, 2015). Worldwide, large numbers of sustainability experiments are carried out. In these experiments, various types of innovations (for example, new technologies or new ways of doing things) are tested. These experiments may be the starting point of a diffusion process that in turn contributes to the transformation of existing production and consumption systems. However, we know that this diffusion is problematic (OECD and World Bank, 2014); there are barriers at different levels like the innovating organisation, the technology, the infrastructure, the demand side, and in the wider social and institutional context (Kemp et al. 1998).

The literature suggests that the context conditions on the urban and regional scales are important for successful experimentation and diffusion (Hansen and Coenen, 2015), but there is a considerable gap in our knowledge; that is, a systematic analysis of the mechanisms and the distinct (combinations of) spatial context conditions that enable sustainability experimentation and early diffusion of innovations is lacking.

In this dissertation, we address the following overall research questions:

1. *Which spatial context conditions enable practice-based experiments with sustainability innovations in Europe and the early diffusion of these innovations?*
2. *How can these conditions be improved?*
3. *In which type of city-regions are these conditions favourable?*

We put forward three overall hypotheses:
H1: Various types of experiments have distinctive favourable ‘habitats’, i.e., configurations of local and regional context factors that enable experimentation.
H2: Experiments for social and technological innovation will have different transfer pathways by which these innovations diffuse translocally. We also expect that the diffusion of innovations is facilitated by a ‘harbour’, i.e., a combination of local and

regional context conditions that enable transfer
H3: Frontrunner regions for sustainability experimentation and diffusion host a countercultural milieu, a high number of network connections (supported by a culture of openness, trust, and shared sustainability values), a vibrant environment and the presence of a few distinct actors.

This research especially investigates the spatial *context* conditions. *Project-internal* conditions are included in this research to estimate their relative share in explaining successful experimentation and early diffusion and to control for them in determining the spatial context effects.

When analysing the conditions for experimentation, we focus on the transformative potential of the innovations; thus, we are interested in the conditions enabling the future diffusion of the innovations.

When analysing diffusion, we focus on the translocal diffusion of innovations, i.e., the repetition and reproduction of an experiment in a new context, such as a new city or country (Turnheim et al., 2018).

In this chapter, we report the conditions for experimentation and the conditions for diffusion separately and make a distinction between the project-internal and the context conditions using the two main dimensions of the conceptual framework developed in Chapter 1 of this research (experimentation versus diffusion and project-internal versus context conditions; see Fig. 1.1).

6.2 Summary of the results and conclusions

RESEARCH QUESTION 1: WHICH SPATIAL CONTEXT CONDITIONS ENABLE PRACTICE-BASED EXPERIMENTS WITH SUSTAINABILITY INNOVATIONS IN EUROPE AND THE EARLY DIFFUSION OF THESE INNOVATIONS?

The results of Chapters 2, 3, 4 and 5 provide a coherent overview of the spatial context conditions that enable practice-based experiments with sustainability innovations in Europe and of the early diffusion of these innovations (research question 1). We found that three project-internal and seven spatial context conditions facilitate experimentation and diffusion (the cultural conditions are subdivided into three aspects). Table 6.1 presents an overview of these conditions.

Table 6.1. Summary of the findings regarding project-internal and context conditions that enable experimentation and diffusion. Only the conditions found in more than one chapter of this dissertation are listed here; each asterisk represents a finding in one chapter.

Conditions	Detailed findings	Relevant for experimentation	Relevant for diffusion
Project-internal			
Technical quality of the innovation	The technical performance of the innovation, also measured by the number of beneficiaries as a proxy.	**	
The skills of the people involved	Various skills, such as entrepreneurship, motivation, leadership and perseverance.	*	*
Project activities aimed at media attention	Communication and marketing activities.	*	*
Context			
Vision	A local or regional or sectoral vision of the future.	**	
Learning	The dissemination of learning experiences; social learning in group meetings and in regional networks.	**	
Countercultural milieu	Alternative groups for whom community building is important, shaping a beneficial context for experimentation through alternative ideas, spiritualities and lifestyles. Some groups have a radical character.	**	
Networks	Local, regional and global sustainability networks (for instance global intercity networks).	***	**
Regional actors	The local and regional government with distinct policy instruments and the role of the university in knowledge exchange and learning processes.	**	**
Vibrant environments	Meetings, conferences and festivals		**
Culture: openness	Openness towards ideas and innovations from others.	*	**
Culture: trust	Trust towards innovations and other people.	**	**
Culture: shared sustainability ambition	A shared sustainability ambition, e.g., in networks.		*

As shown in Table 6.1, the conditions that enable experimentation are partly different from the conditions that enable early diffusion. The results are reported separately

below.

Conditions for experimentation

To analyse the context conditions for experimentation, the 'habitat' concept is developed. The concept is inspired by other similar concepts from the literature, such as the 'fertile soil' (Sekulova et al., 2017) and the Territorial Innovation Model (Moulaert and Mehmood, 2010). The habitat is defined as a configuration of spatial context factors that enables experimentation. Four archetypical habitats have been constructed that we label as follows: the Valley, the Makerspace, the Middleground and the Do-it-ourselves habitat.

A main project-internal condition that enables the future diffusion of the innovations involved in experimentation is the *technical quality* of the innovation. It was also a significant variable in the quantitative research in Chapter 5. Technical quality is an interest of a potential adopter (Hall, 2005). We argue that technical quality is an essential condition; when technical quality is insufficient, future diffusion will be problematic.

In these projects, the *skills* of the people involved are important. The relevant skills and competences found in this research were varied, such as entrepreneurship, motivation, leadership and perseverance.

Users are an important group of people involved in experimentation. *User involvement* in so-called living labs supports future diffusion since this setting imitates real-life conditions (Schliwa and McCormick, 2016). In Chapter 2, we found that user involvement was the most important condition that enabled experimentation.

Regarding the context conditions, we found that a local, regional or sectoral *vision* of the future facilitates experimentation. This is in line with Hekkert et al., (2007), who noted that visions, especially when shared by many actors, have a role as a selection environment for innovations. Additionally, we found that a vision is also vital in building multiactor networks.

For the stakeholders involved in experimentation, we found that *learning* is important. We observed that stakeholders are primarily interested in exchanging knowledge, ideas, and experiences. This knowledge exchange is classified as first-order learning. We also observed some second-order learning.

There is a distinct role for stakeholder groups from a *countercultural milieu*. Countercultural individuals collectively shape a beneficial context for experimentation through alternative ideas, spiritualities and lifestyles. We found an important enabling role for countercultural movements in various communities and districts. Some of them have a radical character (i.e., they have a strong resistance against the mainstream), such as groups present in 'fabrication labs' and 'hackerspaces'. We measured the countercultural milieu in Chapter 5 with two variables: the hipster index and community action for the environment. Both variables showed a highly significant correlation with the (future) diffusion of innovations.

The various stakeholders are often members of local and regional *networks*. Here, we found that the cooperation between partners enables knowledge diffusion, confirming that a diversity of actors in these networks stimulates social learning (Sol et al., 2013).

We found that one distinct local and *regional actor* has an important role in experimentation processes: the government. Local and regional governments fund experiments. Moreover, they often create areas with fewer regulations where experimentation is allowed.

Finally, we found that several *cultural conditions,* such as openness (towards ideas and innovations from others) and trust (towards innovations and other people) on the local and regional scales, appear important in the various encounters between people. Chapter 5 confirmed that cultural openness was a significant variable. We conclude that these cultural conditions act as general enablers in the various encounters between people, such as in group and network meetings, for knowledge exchange and social learning processes.

We emphasise that a *combination* of conditions is beneficial for experimentation. In the research in Chapter 3, in the case of the Karlsruhe-future district, the interviewees indicated that it is important that this combination of context conditions be present, leading to a more mature habitat. This combination concerns the presence of a large group of motivated citizens, a history of several years of initiatives in the district, common underlying values, participation by a countercultural group, an existing district network, an environment where learning between projects is stimulated, a supportive project from the university and, finally, supportive urban policies. It is concluded that the habitat concept is valuable in our understanding of

how different spatial contexts enable sustainability experiments.

It is concluded that three project-internal and six spatial context conditions enable sustainability experimentation. Combined, these context conditions constitute the habitat for experimentation. The context conditions we found are consistent with earlier findings from other researchers, although the roles of a countercultural milieu and of the local and regional government were understated in the literature.

Hypothesis 1 proposes that various types of experiments have distinctive favourable 'habitats', i.e., configurations of local and regional context factors that enable experimentation (this was tested in Chapters 2 and 3). Indeed, we found differences in the enabling conditions for the various types of experiments. Chapter 3 found that for experiments with social innovations, trust is important (this was found to be less important for experiments with technological innovations). Additionally, for guided experiments, the existence of a local or regional vision is important; this is less important for grassroots experiments. These findings make Hypothesis 1 plausible. However, we did not find systematic patterns in the different configurations of enabling conditions.

Conditions for diffusion

To analyse translocal diffusion, we have developed a new conceptual model with explanatory power in which translocal diffusion is shaped by an interplay of types of experiments (such as experiments with technological and social innovations), transfer pathways (the mechanism by which innovations diffuse translocally) and harbours (the combination of local and regional context conditions that enables translocal diffusion).

We found that a main project-internal condition that enables translocal diffusion is the execution of *project activities aimed at media attention*. Media attention sometimes directly concerns the transfer of knowledge regarding the innovation and also enables others to start a successive experiment. In the quantitative research in Chapter 5, this variable significantly correlates with the diffusion of innovations.

In these projects, *skilled people* are needed. In the research in Chapter 4, respondents did not provide details on which skills are important. The literature suggests that the skills that enable diffusion are related to the education of the people involved (Fitjar and Rodríguez-Pose, 2015).

Regarding *user involvement*, it is widely acknowledged that users contribute to experimentation with innovations (Meelen, 2019). This is also what we found in Chapter 2. However, regarding diffusion, the results of Chapter 5 show that in projects where user involvement is very high and where citizens are the key actors, user involvement is negatively correlated with the transfer of innovations to other locations. Apparently, there are limitations to the roles that users play in diffusion. The communities involved lack resources such as funding, skills and well-defined plans for growth (Hossain, 2016; Meelen, 2019). In addition, these groups are often inwardly oriented (De Moor, 2013).

Regarding the context conditions, various sustainability *networks* are found to be important for diffusion; they act as knowledge channels. This is in line with the observations of Van Oort and Lambooy (2019). Technological innovations, which have a low degree of embeddedness in local cultural and institutional contexts, travel relatively easily to other regions over larger distances with similar economic and institutional characteristics compared to social innovations. For the diffusion of technological innovations, a significant correlation is found with the city membership of global sustainability networks.

Two *regional actors* are important in enabling the translocal diffusion of innovations: local and regional governments and universities. Governments are especially important for giving publicity to experiments. Universities have a broad role in knowledge exchange and learning processes, e.g., by organising network meetings. In Chapter 5, we also found a significant correlation with the size of the university, measured by the number of students enrolled.

Furthermore, members of networks and other communities meet in *vibrant environments* such as meetings, conferences, festivals and fairs. Vibrant environments offer the possibility for face-to-face contact. In Chapter 4, it was found that in the majority of cases, face-to-face interactions are needed for the transfer of knowledge and ideas to people from other locations (which we consider as part of a translocal diffusion). Chapter 4 found that festivals play a remarkable role in these face-to-face interactions. This finding was not confirmed in the research in Chapter 5. The dataset used in Chapter 5 covers international cultural festivals. Most likely, the majority of the festivals in this dataset are focused on target groups other than those involved in sustainability experimentation. With the findings in Chapter 5, we conclude that only distinct types of festivals are important for the exchange of knowledge and the diffusion of sustainability innovations, such as a sustainability festival in Toulouse (found in Chapter 4).

In these sustainability networks and in vibrant environments, *cultural conditions* are found to facilitate the exchange of innovations, knowledge and ideas. These cultural conditions concern openness and trust. Both variables are also highly significant in the quantitative analysis. For diffusion, in the research in Chapter 4, we found an additional relevant cultural condition: a shared sustainability ambition in the community and between the communities that 'send' and 'receive' innovations. We also found indications of the importance of a shared sustainability ambition in the literature. However, in Chapter 5, this finding was not confirmed; this condition, therefore, has only one asterisk in Table 6.1. The indicator used in Chapter 5 for a shared sustainability ambition measures attitudes towards climate change in regions. The findings in Chapters 4 and 5 are valuable for future research; more fine-grained data are probably needed to test the importance of shared values in networks. These data were not present in the available dataset.

Finally, we find that a *combination* of the context factors is beneficial for translocal diffusion. This combination concerns networks, vibrant environments, regional actors and cultural conditions. We conclude that the harbour concept is valuable in our understanding of how the spatial context enables the early diffusion of sustainability innovations.

We conclude that from a plethora of conditions mentioned in the literature, two relevant project-internal conditions and four relevant spatial context conditions that enable diffusion are identified, as mentioned above. We have addressed gaps in our understanding of the transfer mechanisms and of the conditions that enable the early diffusion of sustainability innovations. We also conclude that early diffusion, although considered part of activities in niches (Geels, 2018), requires partly different conditions than experimentation.

Hypothesis 2 states that experiments for social and technological innovation have different transfer pathways by which these innovations diffuse translocally. It was also expected that the diffusion of innovations would be facilitated by a 'harbour', i.e., a combination of local and regional context conditions that enable transfer (this was tested in Chapter 4 and 5). This hypothesis is supported by the findings. We found a large contrast between the pathways of technological innovations and social innovations. Technological innovations are transferred relatively easily compared to social innovations. The transfer of social innovations is more challenging: the transferred knowledge has a more tacit character, and innovations are more strongly embedded in local cultural and institutional contexts. We also found indications that

the diffusion of innovations is facilitated by a harbour. The contrast between the context conditions that enable the diffusion of technological innovations and social innovations was limited.

Coherence in context conditions for experimentation and diffusion

In the various chapters of this dissertation, we have identified several spatial conditions that enable experimentation and diffusion. In this section, we zoom in on the overlap and the differences between the conditions that enable experimentation and diffusion, their coherence, and how these results relate to the transition studies literature.

We have identified seven main spatial context conditions: a vision, learning, a countercultural milieu, sustainability networks, a few regional actors, and a vibrant environment and culture (subdivided into three aspects); see Table 6.1.

With these results, we contribute scientifically to a spatial articulation of the niche for sustainability experiments, as defined in transition studies. Experimentation and early diffusion are considered activities in niches for sustainability experiments (Geels, 2019; Hommels et al., 2007). Through both qualitative and quantitative research, it is shown that the list of three main enabling factors, as discriminated in transition studies (see Schot and Geels, 2008), must be expanded to seven spatially explicit factors, mostly (but not exclusively) present on a local or regional scale.
The list of three main enabling factors, as discriminated in transition studies, was extended in this research by deriving these additional factors partly from the literature on regional innovation systems and then testing whether these factors were also valid for experimentation and the diffusion of sustainability experiments. Some factors found, such as the presence of a countercultural milieu (Chapter 3), the role of festivals (Chapter 4) and the government (Chapter 2), were understated in the RIS and transition studies literature.

The conditions mentioned in Table 6.1 are related; this is shown in Fig. 6.1. The arrows between the four layers have distinct meanings:

- On the lowest layer, layer one, culture is considered a facilitating property in the various encounters between people, such as in a countercultural milieu (found in Chapter 3), in networks (found in Chapter 5) and in vibrant environments (found in Chapter 5). Culture facilitates the exchange of innovations, knowledge and ideas in this milieu and in these environments and facilitates social learning

processes in networks. The arrows towards layer two indicate this facilitating property. It is also possible that these encounters influence cultural properties; this is indicated with backwards arrows.

- In layer two, the other six main enablers are presented. The arrows towards layer three indicate the importance of their combined presence constituting a habitat, which enables experimentation, and a harbour, which enables diffusion.
- In layer three, the two combinations of enabling conditions are presented. The arrows to layer four indicate that they are mostly present at the local and regional scales.

Figure 6.1 shows that the factors that enable experimentation are partly different from the factors enabling diffusion. The presence of a *vision*, *learning* and a *countercultural milieu* are relevant conditions for experimentation but not directly for diffusion. (Although indirectly, they may be relevant because these factors may increase the transformative potential for future diffusion, as indicated by Ghosh et al. (2021) and Wolfram et al., 2019)). The presence of a *vibrant environment* is relevant for diffusion but not directly for experimentation. These differences in the factors that enable experimentation and diffusion refer to a possible tension. See Section 6.3 for a further elaboration of this tension.

The figure also shows that some conditions facilitate experimentation as well as early diffusion: *networks*, *regional actors* and *culture*. *Networks* facilitate social learning, which is a key process in experimentation. In diffusion processes, the role of networks is different; they act as knowledge channels. *Regional actors* (especially local and regional governments) are not only important for experimentation in, for example, creating areas with fewer regulations where experimentation is allowed, but they are also important for diffusion in which they play a different role by giving publicity to experiments. *Culture* facilitates social learning processes for experimentation, as well as knowledge transfer that enables diffusion.

We remark that in Fig. 6.1, only the context conditions are presented. These conditions enable experimentation and diffusion, but only when crucial project-internal conditions are also met: the technical quality of the innovation, the skills of the people involved and the project activities aimed at media attention. The importance of this combination was confirmed in the quantitative analysis (Chapter 5); the contributions of internal versus context conditions in explaining diffusion are about equal in size.

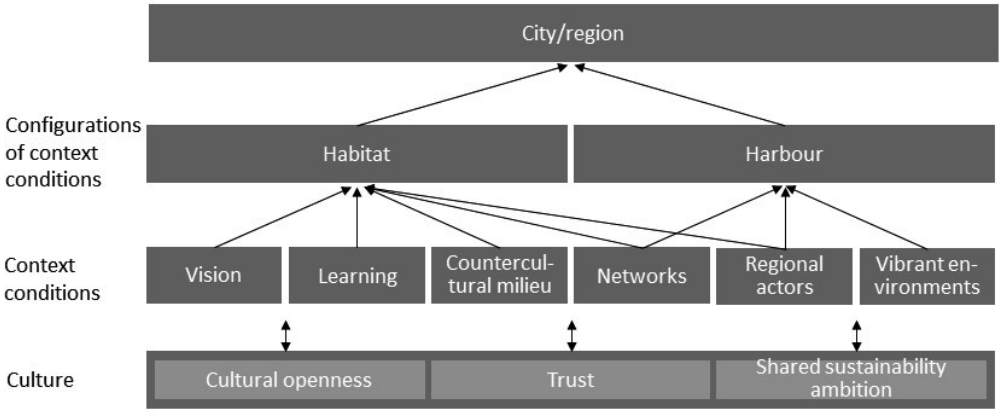


Fig. 6.1. The main spatial context conditions that enable experimentation and early diffusion of sustainability innovations. The meaning of the arrows is explained in the text.

RESEARCH QUESTION 2: HOW CAN THE CONTEXT CONDITIONS FOR EXPERIMENTATION AND EARLY DIFFUSION BE IMPROVED?

An important part of this research concerns the question of whether the spatial context conditions for experimentation and early diffusion can be improved. Answering this question is valuable for practitioners and supports the acceleration of the sustainability transition.
We distinguish among three time horizons at which these improvements are shaped: the short, medium and long term.

We found various conditions that may be improved in the *short term* by interventions of local and regional stakeholders. In action-oriented workshops, reported in Chapter 3, stakeholders indicated that they see possibilities in the short term, e.g., developing networks, creating a learning environment and mobilising more political support for experimentation.

A second group concerns conditions that have been formed and improved in the *medium term* over several years of experimentation. We can understand this formation as a process in which experiments and contexts coevolve. This process of coevolution was described by Longhurst (2015). In his case study on the village of Totnes, a so-called Transition Town, he shows that after almost a century of experimentation, a localised milieu was formed, with a growing proliferation of alternative practices, institutions, and organisations. We found indications of coevolution in the Karlsruhe – future district case, in Chapter 3. The city of Karlsruhe

has several years of experience with experimentation. Over time, the context conditions also improved: the analysed district evolved from an industrial area to a creative district, a new counterculture emerged, and a project started by the university to give support to experimentation. These processes may have taken several years to complete.

Finally, some other factors, such as regional cultural factors, refer to localised assets and capabilities that have been formed in a *long-term* development process; they have a path-dependent nature and are rooted in the socioeconomic and political history of regions (Moulaert and Nussbaumer, 2005). Some of these cultural differences can be explained by processes from centuries ago, for example, by the differences between countries and regions that were or were not part of the former Roman Empire (Hofstede, 1980). The path-dependent nature and slow evolution of such assets and capabilities make it difficult for stakeholders to actively influence them (Asheim and Gertler, 2006; Maskell and Malmberg, 1999).
We found various indications of conditions that are strongly rooted in the history of regions. In Budapest, we found a deep food awareness, which is likely to have originated from the historical Hungarian 'kitchen garden' system (Balázs et al., n.d.). In Toulouse, in the empirical research, we found a strong technological orientation in experimentation, which is likely rooted in a long history of the manufacturing industry in the region and in a century of operations in the aeronautics industry.

RESEARCH QUESTION 3: IN WHICH TYPE OF CITY-REGIONS ARE THE CONTEXT CONDITIONS FOR EXPERIMENTATION AND EARLY DIFFUSION FAVOURABLE?

While observing patterns of urban sustainability experimentation and diffusion in Europe, researchers have identified particularly localised high densities for various types of sustainability experiments (Feola and Butt, 2017; Monstadt, 2007; Hielscher et al., 2015). In research question 3, we address in which type of city-regions the conditions for sustainability experimentation are favourable. In answering this question, in Chapter 5, we searched for frontrunner regions in Europe, i.e., regions with favourable spatial context conditions for experimentation and diffusion, thereby acting as an example for (other pioneers in) other locations.

The results showed that frontrunner regions host a countercultural milieu, sustainability networks enabled by openness and trust, a vibrant environment and two enabling regional actors: the local and regional government and the university. Overall, frontrunner regions are strongly related to cities and regions with high social

and physical openness (measured by cross-cultural contact with people in other countries, city memberships in global sustainability networks and international meetings**).** Among the European regions analysed, frontrunner regions are mainly found in Northern and Western Europe, such as the regions of Noord-Holland (Amsterdam), Utrecht and Midland & Eastern Ireland (Dublin), with some isolated hotspots in other parts of Europe, such as Budapest and Catalunya (Barcelona).

Hypothesis 3 proposes that frontrunner regions for sustainability experimentation and diffusion host a countercultural milieu, a high number of network connections (supported by a culture of openness, trust, and shared sustainability values), a vibrant environment and the presence of a few distinct actors (this was tested in Chapter 5). The findings support this hypothesis; however, they do not concern shared sustainability values. From the literature (Capdevila, 2018), it was expected to find a correlation with the transfer of innovations, but this was not confirmed in this dissertation. The findings regarding shared sustainability values are valuable for future research; more fine-grained data are probably needed to test the importance of shared values in networks.

6.3 Discussion

The generalisability of the results

An important motivation for us to conduct this research was to obtain insights that are relevant to the practice of supporting sustainability experiments. Our cases addressed a diversity of experiments and spatial contexts. In Chapters 2, 3 and 4, we developed a framework for creating a diverse set of cases using two dimensions: the knowledge dimension (from technological to social innovations) and the governance dimension (from guided to grassroots experiments); see Figure 1.2 in Chapter 1. The diversity along the knowledge dimension is relevant because experiments with technological innovations rely on codified knowledge more than experiments with social innovations; this difference is expected to be relevant in diffusion processes. The diversity along the governance dimension is relevant because, in contrast to grassroots experiments, guided experiments show strong involvement from governments or firms and a clear protocol for learning. This difference is also expected to affect diffusion.

The cases were selected along the quadrants of this analytical framework, which resulted in a large contrast in experiments and contexts. In addition, attention was given to the distribution of experiments and contexts across sectors and across countries in Europe. However, the choice for this framework also has some

shortcomings. For instance, additional dimensions could have been included, such as the dimension from incremental to radical innovations. However, we did not use this difference as the main dimension since we selected cases characterised by 'radical incrementalism', i.e., cases that are aimed at breaking, step-by-step, with the existing regime without assuming that a classical revolution is necessary. In other words, we were not purposively searching for a contrast in the degree of radicality.
By selecting the cases along the dimensions of Figure 1.2, it was expected from the transition studies and regional innovation systems literature that this choice would lead to large variations in experimentation and diffusion mechanisms, probably resulting in variations in enabling context conditions.

There are also some potential shortcomings in the type of experiments and contexts selected in this study. In Chapters 3 and 4, we have studied a relatively large number of grassroots experiments performed by alternative groups in European cities. As a result, innovations by less radical groups may be underrepresented. See also the discussion point below on the innovativeness of the cases.
Although some cases in rural areas are included in Chapter 2, the emphasis in this research is on experiments in cities. In the literature, it is argued that cities have always been important engines of innovation and are locations where utopian ideals have been tested (Bulkeley and Castán Broto, 2013; Florida et al., 2017). In Chapters 3 and 4, we deliberately selected innovative projects in innovative urban contexts. However, we did not want to select very radical innovations in radical contexts, such as the cases of Masdar City, Arcosanti, and Damanhur. These cases are somewhat disconnected from existing systems by design, making them neither adaptable nor adoptable (Evans et al., 2016b). Furthermore, there remains a possible bias towards university cities; all cases in Chapters 3, 4 and 5 are almost exclusively university cities. This is why we think that the results with regard to universities and students should be treated with some care. The emphasis on cities implies that conclusions about experiments in rural areas cannot be drawn.

The qualitative research of Chapters 2, 3 and 4 showed that almost all context conditions correlate significantly with the transfer of innovations in Chapter 5. The fact that these context conditions, which were found through qualitative research, have been confirmed through quantitative research, provides more robust support for the overall conclusions.

Innovativeness of the cases
Our research was based on cases characterised by 'radical incrementalism', i.e., cases that are aimed at breaking with the existing regime step by step without

assuming that a classical revolution is necessary. In this research, this aim was translated into a practical criterion for selecting the cases: the projects selected had to be experimental, i.e., a prototype should be present, and there should still be uncertainty about whether it will work in real life and whether it will be embedded in the regime, i.e., the structures of existing systems in societal domains, such as in the provisioning systems for energy or food (Rotmans and Loorbach, 2010).

We have three remarks on the innovativeness of the cases in this research.
First, it is important to note that although the cases had an experimental character, in several interviews in the qualitative research, it appeared that these projects were 'new to the region' but not necessarily ‘new to the world’ (Binz and Gong, 2021). For example, we selected the case of a repair café in the Toulouse region. This repair café was not new to the world but was probably one of the first repair cafés in the region and served as an example for more than 15 successive repair cafés in the same region. It is, however, not certain that we always selected the first innovation in the region; this was not systematically analysed. In the dataset used in Chapter 5, we noticed that a large proportion of the cases were based on a previous project, but it was not indicated where these projects are located (inside or outside the region).

Second, it is emphasised that innovation, especially social innovation, sometimes concerns small details. The community gardens in Budapest, for example, were not innovative in terms of the recipe (i.e., the global concept), but they were innovative in the specific organisational adaptations concerning local embedding. A similar pattern was observed in the translocal distribution of a repair café solution in the Toulouse region. Thousands of repair café projects are underway worldwide. However, in the case of Toulouse, there was an absence of replication, an unaltered transfer. This may indicate continued innovation. It is valuable to analyse this process in more detail with longitudinal research, in which an innovation and its transfer are followed over a longer period.

Third, as stated previously, we did not want to select very radical innovations in radical contexts, such as the cases of Masdar City, Arcosanti, and Damanhur, as these cases are sometimes disconnected from existing systems, which makes them neither adaptable nor adoptable (Evans et al., 2016b).

We conclude that the cases in this research were innovative, not very radical in character, and that we have used the notion of innovativeness in a context-dependent way.

Issues of scale

Our research focused on the spatial context conditions for experimentation and diffusion with an open attitude towards issues of scale; we were interested in conditions from a local to a global scale. The seven context conditions found (see Fig. 6.1) are mostly localised on the local and regional scales, with a few exceptions: the countercultural milieu is localised mostly on a district scale, whereas networks sometimes span a larger, even global, scale. Moreover, the scale level was sometimes difficult to determine, such as in the case of regional funding, where the origin turned out to be funding from the European Union.

In the literature, many of the conditions found in this study, such as learning, networks, culture and vibrant environments, are considered part of the regional innovation system (Hansen and Coenen, 2015; Asheim and Gertler, 2006). However, this does not automatically imply that these conditions are localised on that particular scale; the spatial variation in these factors may, for example, also be present on a national scale, such as indicated in the national innovation literature, regarding institutional and policy conditions (Freeman, 1995). These conditions may also vary on a micro scale, such as with trust, which may or may not present between individuals, for instance, within a company, thereby influencing innovation processes (Murphy, 2006). In this study, when determining the scale level of the context factors, primarily the statements of the respondents were used. In Chapters 2, 3 and 4, in the interviews, we were interested in factors on all scales, from local to global.
For cultural factors, the scale level was often difficult to determine, or could only be determined indirectly, because respondents linked cultural factors to certain actors (for example, the trust in a countercultural group) or to networks on a distinct scale.
The conclusion is that the spatial scale of the habitat and harbour concepts can be pinpointed mainly (but not exclusively) at the local and regional scales.

Recommendations for practitioners

In this research, it was important for us to obtain insights that are relevant to the practice of supporting sustainability experiments. It is widely acknowledged that transition processes show large uncertainties and are unpredictable; these processes cannot be managed in a classical ‘command and control’ approach (Rotmans and Loorbach, 2009). However, our results show that there are several possibilities for actively improving conditions that enable experimentation and early diffusion. The keys to these improvements often lie in the project-internal conditions and in the context conditions on the local and regional scales.

Experts in government bodies apply various policy instruments for experimentation and diffusion (such as offering room for experimentation, granting subsidies, publicising good examples and building networks), but this research has shown that the list of possibly relevant context conditions is actually much longer.

We have noticed that it is not yet common practice in local and regional experimentation processes to actively try to improve the context conditions. We recommend exploring the possibilities for this improvement by evaluating the existing and needed project-internal and context conditions on site. We recommend carrying out this evaluation in close cooperation with regional stakeholder networks. This evaluation can provide better insights into what is needed for experimentation and diffusion based on local and regional situations.

A roadmap for the evaluation of the project-internal and context conditions may practically look like this:

1. Choose a theme in which a transition approach is used. Within this theme, select a subsystem where a number of clearly related experiments are carried out, such as 'local food', 'biobased economy' or 'decentralised energy systems'. The mapping of a sociotechnical configuration, by Geels (2002), can serve as an example for this selection process.
2. Prepare a questionnaire for the evaluation of experiments on the transformative potential of experimentation and/or on the diffusion of innovations. The questionnaires in Chapters 3 and 4 can serve as an inspiration.
3. Execute individual interviews. It is suggested that the pioneers themselves be consulted primarily, since they can indicate first-hand what they need for experimentation and diffusion and which barriers exist. It is suggested that a long list of possible factors from the literature be used, and that the interviews be used to arrive at a regional shortlist, specifically for this subsystem and for the local situation. It is also recommended that more detail be added to the factors, if possible, which will increase the applicability in practice.
4. Prepare a summary of the findings, and organise an action-oriented workshop, where the pioneers and other relevant regional stakeholders are present. At least two topics can be discussed in this workshop:

    - A summary of the findings from the interviews
    - A discussion on what to do with the results and possible next steps to be taken towards possible joint activities of respondents and other stakeholders, towards building or strengthening a regional sustainability network, and

towards an action plan for improving the context conditions.

The above roadmap has been carried out successfully, largely along these lines, in the research described in Chapter 3. In this research, respondents and stakeholders appreciated the action-oriented workshop. It was not always possible to immediately arrive at actions to be taken, because these processes often take time.
It is important to remark here that the expectations of the results of this evaluation should be modest for several reasons. First, this dissertation has shown that some context conditions are difficult to improve, such as cultural factors. Second, this approach is focused on experimentation and early diffusion; this is only a part of the full transition. Third, this evaluation is not yet proven in practice; it requires an experiment in itself to test and improve this roadmap.

Extension of the conceptual model
This dissertation focuses on the conditions that enable the experimentation and early diffusion of sustainability innovations, and to this end, we distinguish between project-internal factors and spatial context factors. These dimensions are captured in a simple conceptual framework that was presented in Chapter 1; see Fig. 1.1.
With the findings from this dissertation, it is now possible to expand the conceptual framework (see Fig. 6.2). The conceptual framework developed in Chapter 1 is further expanded on three points:

- The transformative potential. A new insight in transition studies is that even though the diffusion of innovations takes place in the future, it is already possible to improve the 'transformative potential' during the experimentation stage (Ghosh et al., 2021; Wolfram et al., 2019). This principle is applied in the research design of Chapter 3 and Chapter 5, where we found indications that this transformative potential exists. This potential was also recognised by the respondents in the research in Chapter 3 and Chapter 5, where the factors that enable experimentation were shown to correlate with the actual diffusion.
- The principle of coevolution. The notion of coevolution is used in this research to emphasise that experiments take place in mutual interaction with their spatial context, i.e., the context can improve the experimentation, and at the same time, by experimenting, the context can improve. This process of coevolution has been described by, among others, Longhurst (2015) in his analysis of a Transition Town. That it is possible to improve the context by experimentation was suggested by Schot and Geels (2007), who stated that ‘innovations construct their own niches’. We did not systematically analyse coevolution, but we observed indications of coevolution in this research, in the case Karlsruhe – future

district, in Chapter 3. The city of Karlsruhe has several years of experimentation experience. Over time, the context conditions also improved (the analysed district evolved into a creative district, a new counterculture emerged, and a project started with the university to give support to experimentation). These changes probably created a 'mature' habitat for experimentation.
This process of coevolution may also occur in other cities; however, this would have to be verified in additional research.

- The habitat and harbour concepts. With these concepts, mentioned in the cells of Fig. 6.2, it is suggested that for successful experimentation and diffusion, it is important to have a *configuration* of spatial context factors available. The literature indicates that the quality of the mutual relatedness of the factors is relevant for creating a 'fertile soil' for sustainability experimentation (Sekulova et al., 2017). In Chapter 3, we found indications of the importance of this configuration in the case of Karlsruhe – future district. Here, we observe a large group of motivated citizens, a history of several years of grassroots initiatives in the district, common underlying values, participation by a countercultural group, an existing district network, an environment where learning between projects is stimulated, a supportive project from the university and supportive urban policies. For the harbour concept, we found indications in four cities studied (Chapter 4). In Chapter 5, we found additional indications that combinations of context conditions in a 'harbour' are relevant to explaining diffusion.

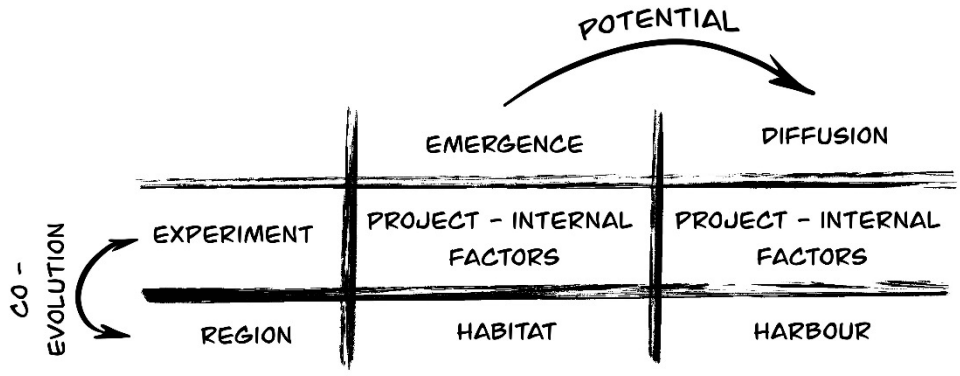


Fig. 6.2. Extended conceptual framework

Avenues for further research

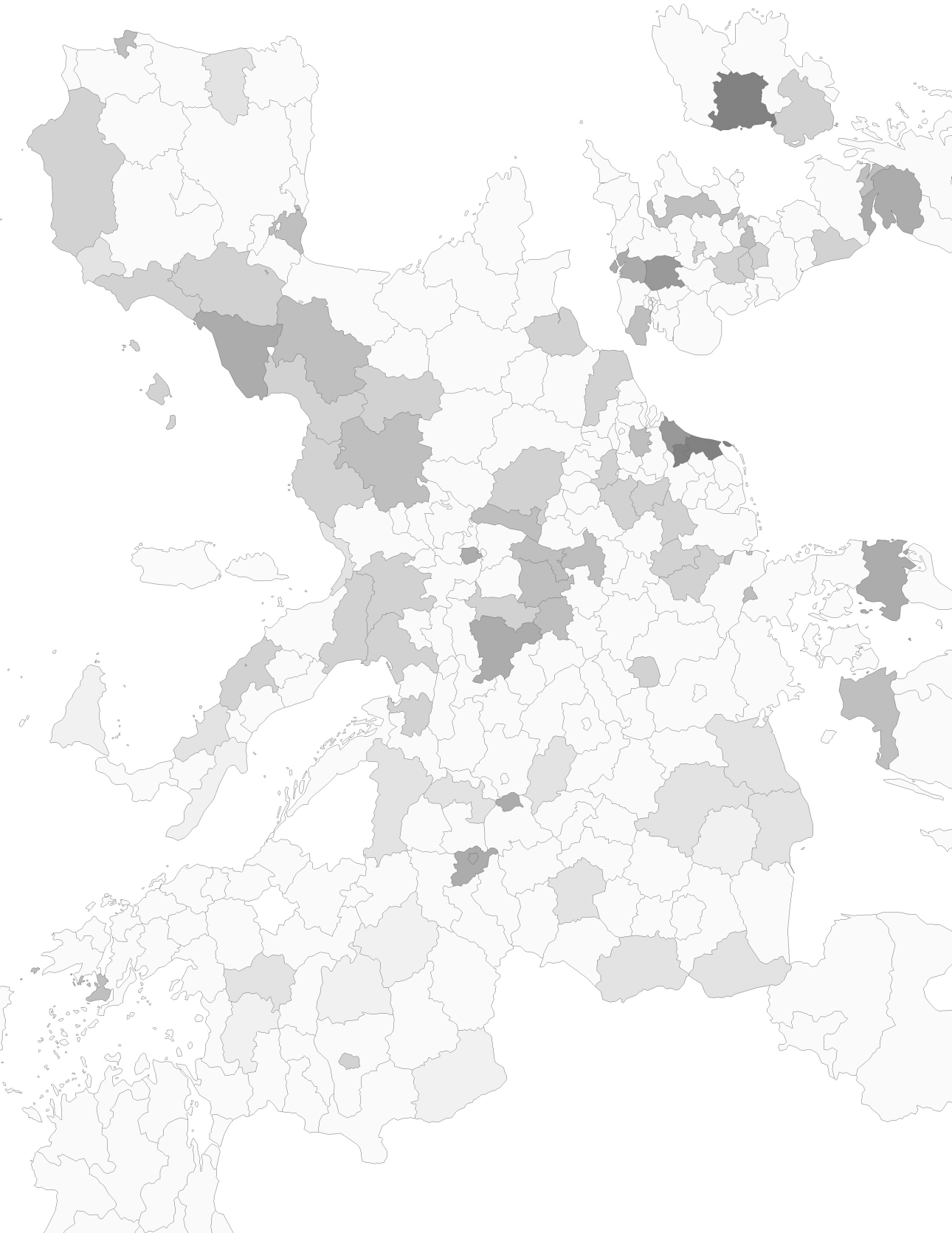
In the final phase of the research of this dissertation, we have arrived at two important broader avenues for further research, which we believe are of vital

importance for accelerating the transitions from a geographical perspective. The first question concerns the properties of the region itself; the second question concerns the shared properties between regions.

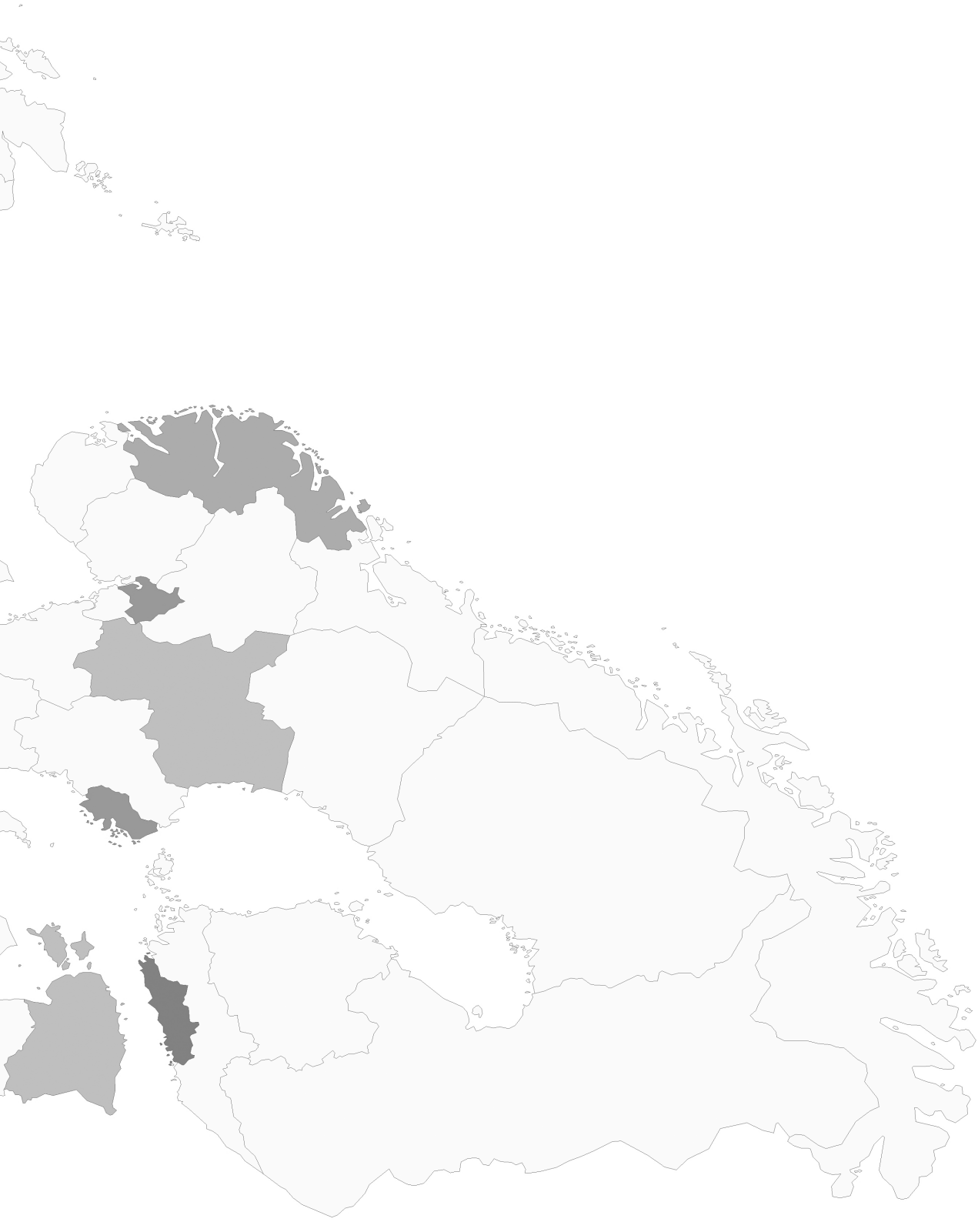
The first important question is whether the region can provide the spatial context conditions for experimentation as well as for diffusion.
The research in this dissertation shows that there are some differences between the context conditions for experimentation and diffusion, such as the presence of a countercultural milieu for experimentation and a vibrant environment for diffusion. Additionally, we found that the enabling role of actors and networks is different in the experimentation and diffusion stages. In this research, we did not observe a 'pilot paradox'. In this case, the conditions that enable sustainability experimentation would constitute a barrier to broader uptake, as suggested by van Buuren et al. (2018). It is, however, useful to analyse possible tensions in the context conditions and in the roles of actors and networks.
These differences in context conditions can also be traced back towards differences between the main concepts in the two disciplines underlying the geography of transitions research: transition studies and regional innovation systems research. In transition studies, it is supposed that nurturing in a protective space is a condition for experimentation (Smith and Raven, 2012). This suggests that temporary isolation is desirable. In contrast, in regional innovation systems research, openness is considered one of the main conditions for diffusion (Boschma, 2005; Glaeser et al., 1992; Iammarino and McCann, 2013).
New insights can be obtained through longitudinal research. Such a study should track the experimentation with sustainability innovations and the diffusion of these innovations over a longer period of time, allowing us to analyse whether the enabling context factors change over time. It is also relevant to include the concept of transformative potential in such research. This concept suggests that it is possible to identify (and possibly improve) specific spatial conditions during the experimentation phase; these conditions possibly increase the chance of future diffusion.

The second important question concerns the shared values and ambitions between innovative niches for sustainability experimentation in different regions and their contribution to the global sustainability transition.
In the geography of transitions literature, the central role of visions and informal localised institutions (such as norms, values and practices) is well known (Hansen and Coenen, 2015). The literature often refers to the importance of shared values and ambitions on a local or regional scale. Here, however, we refer to the possible

emergence of shared sustainability values and ambitions globally *between* innovative niches in different regions. The presence of shared values and ambitions is important for facilitating the translocal diffusion of innovations, knowledge and ideas. In the research of this dissertation, we have found some indications for the existence of these shared values and ambitions, such as in global communities of urban food and of repair cafes or in and between countercultural groups located in different European cities. We observed countercultural groups sharing ambitions for developing radical innovations focused on small-scale and local solutions in grassroots experiments. The literature confirms these shared ambitions, in which examples are given from countercultural sustainability groups that share alternative ideas, lifestyles or spiritualities (Longhurst, 2015; Wittmayer et al., 2016). Another indication of the relevance of shared ambitions is the important role of global intercity sustainability networks in the diffusion of innovations, as found in Chapter 5. Future research could be based on fine-grained value surveys between actors and networks in various regions and in global networks.



Epilogue



As an epilogue and not as a part of this research, I want to remark that an additional value survey, as suggested in Chapter 6, could also shed light on the existence of a 'global community', as referred to by Era, a respondent in our research whose words form the prologue of this dissertation. This global community may cover a utopian image of various elements found in this dissertation: a community developing innovations distributed in and between local and regional networks in cities and regions worldwide with a shared sustainability ambition well connected to each other via global networks and supported by a culture of openness and trust. Such a community can be of great importance for accelerating the global sustainability transition towards a better world.

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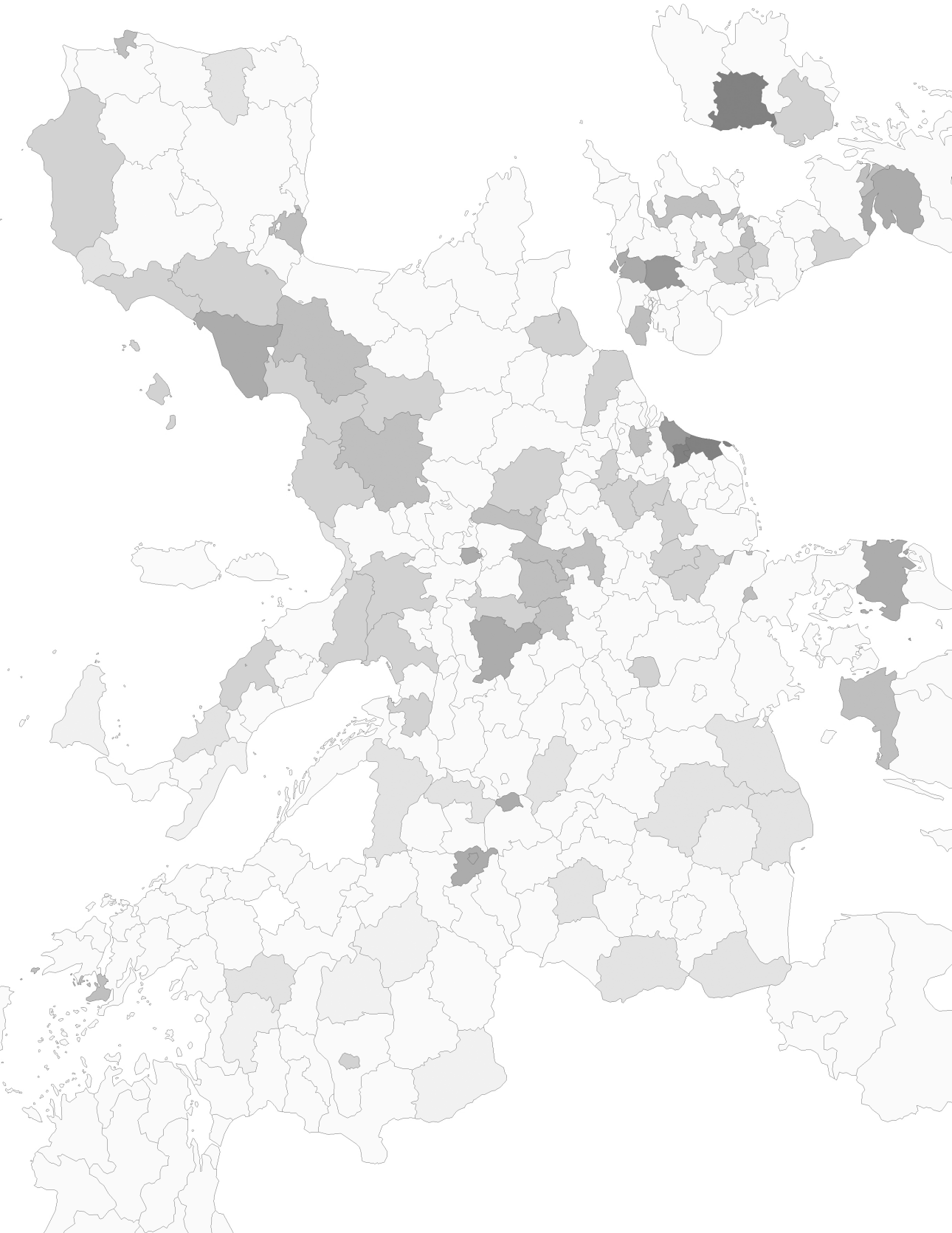

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Summary

Almost every day, we are confronted with alarming reports on topics such as the possible collapse of a glacier in Antarctica, the changing growing season of plants and the decline of the bee population. These are alarming signals that come close to our daily lives and are a sign of a much larger underlying sustainability problem. We are approaching the biophysical limits of the Earth system, as is the case with climate change, the biodiversity loss of plants and animals and the human disruption of the nitrogen cycle. The urgency of the global sustainability challenge requires a fundamental system change: a transition of the systems, e.g., the provision of energy, food and mobility. To date, however, progress has been rather limited because these systems exhibit high degrees of inertia.

Currently, large numbers of sustainability experiments are being carried out worldwide. This experimentation is related to the approach of 'radical incrementalism'. In this approach, the view is that a radical transition is needed, without assuming that a classical revolution is necessary. The transition can then be realised along an incremental path; the starting point is formed by carrying out practice-based experiments.

Sustainability experiments in this research are considered the activity to test a prototype of a technological or social innovation in practice in a 'real-life' setting. These experiments are being carried out by a variety of actors. *Citizen groups* experiment with small-scale local solutions, such as community gardens and energy cooperatives, and a*lternative groups* test radical innovations in, for example, 'fabrication labs' and 'transition towns'. *Firms* test a large variety of innovations and sustainable business models, such as platforms for renting and sharing goods. Additionally, g*overnments* increasingly use experiments to address the complexity of urban sustainability challenges.

The literature on transition studies suggests that this fundamental system change can start small, for instance, in practice-based experiments with innovations mostly in local contexts. These contexts are called *niches*. These experiments may be the starting point of diffusion of these innovations, which is essential for the acceleration of the transition towards a more sustainable system. In this research, we are interested in experiments with sustainability innovations, as well as their scaling up (where the innovation is expanding in geographical scope and duration) and replication (where the experiment is repeated in another location).

In the spatial patterns of urban sustainability experimentation and diffusion in Europe, particular regional hotspots (i.e., localised high densities) are observed, such as in Berlin and Barcelona. We suspect that certain districts, cities or regions offer better conditions for experimentation than others. What may be the cause of these spatial differences, and is it possible to improve these conditions? A better insight into these topics can help to accelerate the global sustainability transition. In this dissertation, the following questions are addressed:

- *Which spatial context conditions enable practice-based experiments with sustainability innovations in Europe and the early diffusion of these innovations?*
- *How can these conditions be improved?*
- *In which type of city-regions are these conditions favourable?*

The research is focused on urban regions because they are important locations for innovation.

In the first part of this research, we mapped the context factors that enable experimentation. We carried out exploratory research in 56 experiments in 14 countries in Europe. Afterwards, we carried out an extensive comparison of experiments in four European city-regions.
We developed the 'habitat' concept to suggest that an experiment be carried out in coevolution with its spatial context. This principle is derived from biology. It is used in this research because we suspect that the context improves the experiment and vice versa. We found indications of coevolution in one city-region. We also constructed typical contexts for experimentation, such as the 'Valley' habitat, which is a favourable context for guided experiments with science-based technological innovations, and the 'Do-it-ourselves' habitat, which is favourable, e.g., for grassroots food and energy initiatives carried out by citizen groups. Elements of these habitats can be found in many city-regions worldwide.

The main context factors that enable experimentation are as follows:

- The presence of a local or regional *vision*. A vision may guide the desired innovations.
- *Learning* from experiments, such as through the dissemination of learning experiences and by social learning in regional networks.

- The presence of a *countercultural milieu*. Members of countercultural groups collectively shape a beneficial context for experimentation through alternative ideas, spiritualities and lifestyles.
- The diffusion of knowledge in local and regional *networks*.
- *Regional actors*, especially local and regional governments that fund projects and create areas with fewer regulations where experimentation is allowed.
- *Culture* in society, such as openness and trust. These factors facilitate social learning processes.

In the second part of this research, we shifted attention to the actual diffusion of innovations. We therefore compared the diffusion of innovations from four city-regions towards other locations. These city-regions were the same as in the first part of this research.
We developed the 'harbour' concept to indicate that a combination of spatial context factors facilitates the 'shipping' of innovations in a figurative sense. We found that this combination was important in all four city-regions. We also found that technological innovations travel more easily around the globe than social innovations. The reason is that for social innovations, the transferred knowledge probably has a more tacit character. Additionally, these innovations are more strongly embedded in the local context. Moreover, we found that innovations are 'translated' rather than replicated; that is, what actually travels is only a part of the innovation, the generalised form of the innovation or only an idea or inspiration related to the innovation.

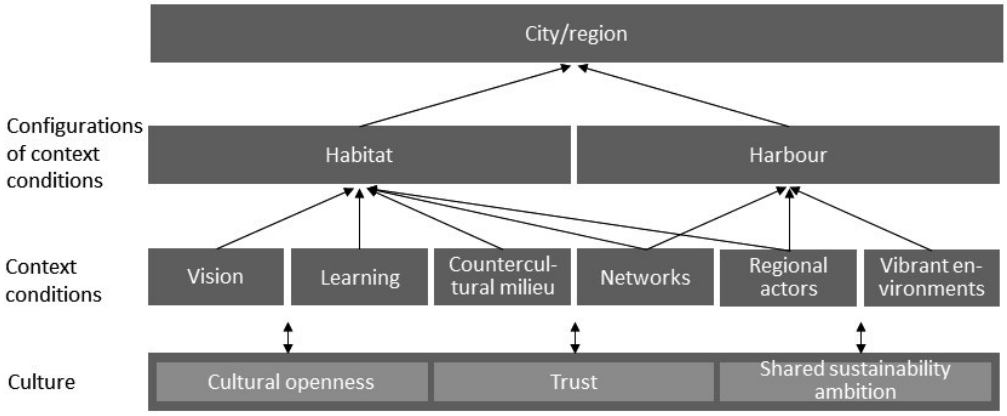
The context factors that enable diffusion are mainly present on local and regional scales. These factors concern:

- Local, regional and global *networks* that foster the diffusion of knowledge.
- Facilitating *regional actors*, i.e., governments, which give publicity to the innovations, and universities, which have a broad role in knowledge exchange and learning processes.
- *Vibrant environments*, such as conferences and festivals, where members of networks and other communities meet and exchange knowledge related to sustainability innovations in face-to-face interactions.
- *Culture* in society, such as cultural openness, trust and a shared sustainability ambition. These factors facilitate the exchange of innovations, knowledge and ideas.

The final part of this research was a search for frontrunner regions in Europe by quantitative research in 89 regions. Frontrunner regions have good context conditions for experimentation as well as for the diffusion of innovations to other locations; they may also act as inspiring examples for others.
It was found that frontrunner regions are strongly related to cities and regions with high social and physical openness (measured by cross-cultural contact with people in other countries, city memberships in global sustainability networks and international meetings). Within the analysed European regions, frontrunner regions are mainly found in Northern and Western Europe, such as the regions of Noord-Holland, Utrecht and Midland & Eastern Ireland, and in other parts of Europe, such as Budapest and Catalunya.

In all parts of this research, we found that in addition to spatial context factors, the project-internal factors also play important roles. Both sets of conditions contribute to successful diffusion to approximately the same degree. Regarding the project-internal conditions, the *technical quality* of the innovation is probably an essential condition for future diffusion. We also found that the *skills* of the people involved play an important role, such as entrepreneurship, motivation, leadership and perseverance. *Communication and media activities* are important in their direct contribution to the diffusion of knowledge from innovation. Additionally, publicity enables others to start a successive experiment, for example, by giving inspiration.

To summarise, the conclusion is that a combination of project-internal and spatial context factors enables practice-based experimentation and the early diffusion of innovations. The context factors in this research can be summarised into seven groups. They are presented in the lower two layers in the figure. The group of cultural factors is subdivided into three subgroups.
The figure illustrates that the group of cultural factors shapes an important supportive layer for other spatial context conditions. These cultural properties facilitate the transfer of innovations, knowledge and ideas between people. The seven context conditions are important in different combinations for experimentation (the habitat) and for the early diffusion of innovations (the harbour). These conditions are mostly, but not exclusively, present on the local and regional scales. The figure also illustrates that with this research, we have gained new insights into *niches* for sustainability experiments. Niches appear to have more enabling conditions than is usually assumed in the transition studies literature. Moreover, with this research, we have made an important contribution to the geographical articulation of the niche.



We have shown that the favourable context conditions for experimentation and diffusion may have been formed in the socioeconomic history of cities and regions. They may have been shaped further by process of several years of experimentation. Several context conditions can be influenced by regional stakeholders, and they can be further improved. This dissertation contains a recommendation for regional networks to assess the existing and needed project-internal and context conditions on site. We present a roadmap for conducting interviews with the pioneers and for organising an action-oriented workshop. In the workshop a.o. actions may be agreed upon to improve the context conditions.

In the course of conducting this research, we met many inspired sustainability pioneers. We have indications that shared sustainability ambitions are emerging *between* innovative niches worldwide. We hope that these ambitions and the insights from this dissertation will contribute to an acceleration of the sustainability transition towards a better world.

Samenvatting

Vrijwel iedere dag worden we geconfronteerd met alarmerende berichten over onderwerpen als de mogelijke instorting van een gletsjer op Antarctica, de verandering van het groeiseizoen van planten en de teruggang van de bijenstand. Dit zijn verontrustende signalen die dichtbij ons dagelijks leven komen, en die een teken zijn van een veel groter achterliggend duurzaamheidsprobleem. We naderen de biofysische grenzen van het systeem aarde, zoals aan de orde is bij klimaatverandering, bij de afname van de soortenrijkdom aan planten en dieren en bij de verstoring van de stikstofkringloop door de mens. De urgentie van de mondiale duurzaamheidsopgave vraagt om een ingrijpende systeemverandering; een transitie van onze systemen voor bijvoorbeeld de energievoorziening, de voedselvoorziening en de mobiliteit. Tot nu toe is de voortgang hierin echter beperkt; het zijn stugge systemen.

Momenteel worden wereldwijd grote aantallen duuurzaamheidsexperimenten uitgevoerd. Deze experimenten zijn gerelateerd aan de benadering van ‘radicaal incrementalisme’. In deze benadering wordt ervan uitgegaan dat een radicale transitie nodig is, zonder aan te nemen dat dit vraagt om een klassieke revolutie. De transitie kan dan gerealiseerd worden langs een incrementeel pad, te starten met het uitvoeren van praktijkexperimenten.

Een duurzaamheidsexperiment beschouwen we in dit onderzoek als de activiteit waarbij een prototype van een sociale of technologische innovatie in de praktijk wordt getest, in een ‘real-life’ omgeving. Deze experimenten worden uitgevoerd door diverse actoren. *Bewonersgroepen* experimenteren met kleinschalige lokale oplossingen zoals collectieve moestuinen en energie-coöperaties en *alternatieve groepen* testen radicale innovaties in bijvoorbeeld ‘fabrication labs’ en ‘transition towns’. *Bedrijven* testen innovaties en duurzame businessmodellen, zoals platforms voor het delen en lenen van spullen. Ook *overheden* maken steeds vaker gebruik van experimenten om de complexiteit van de stedelijke duurzaamheidsopgaven te lijf te gaan.

De literatuur van de transitiestudies suggereert dat die ingrijpende systeemverandering in het klein kan beginnen; bijvoorbeeld in praktijkexperimenten met innovaties, die meestal plaatsvinden in hun lokale omgeving. Deze omgeving wordt ook wel *niche* genoemd. Experimenten kunnen het startpunt vormen voor de verspreiding van de innovaties; dit is essentieel voor het versnellen van de transitie

richting een duurzamer systeem. We zijn in dit onderzoek geïnteresseerd in experimenten met duurzaamheidsinnovaties, hun opschaling (waarbij de innovatie groeit in omvang en duur) en replicatie (waarbij het experiment wordt herhaald op een andere locatie).

In de ruimtelijke patronen van stedelijke duurzaamheidsexperimenten met innovaties zijn regionale hotspots (dwz. gelocaliseerde hoge dichtheden) zichtbaar, zoals Berlijn en Barcelona. We vermoeden dat bepaalde wijken, steden of regio's beter geschikt zijn dan andere. Wat kan de verklaring voor die ruimtelijke verschillen zijn, en is het mogelijk om die omgevingscondities te verbeteren? Een beter begrip hiervan kan de mondiale duurzaamheidstransitie helpen versnellen. In dit proefschrift staan de volgende vragen centraal:

- *Welke ruimtelijke omgevingscondities maken praktijkexperimenten met duurzaamheidsinnovaties in Europa en de vroege verspreiding van deze innovaties mogelijk?*
- *Hoe kunnen deze condities verbeterd worden?*
- *En in welk type stadsregio's zijn deze condities gunstig?*

Het onderzoek richt zich vooral op stedelijke regio's, omdat dit belangrijke locaties voor innovatie zijn.

In het eerste deel van het onderzoek hebben we de ruimtelijke omgevingsfactoren in kaart gebracht die het experimenteren met innovaties mogelijk maken. We hebben een verkennend onderzoek uitgevoerd in 56 experimenten in 14 landen in Europa, daarna hebben we een diepgaande vergelijking uitgevoerd van experimenten in vier Europese stadsregio's. We ontwikkelden het 'habitat' concept om te suggereren dat een experiment wordt uitgevoerd in co-evolutie met zijn ruimtelijke omgeving. Dit principe is bekend uit de biologie. Vertaald naar dit onderzoek houdt dit in dat we vermoeden dat de omgeving het experiment verbetert en vice versa. We vonden aanwijzingen van co-evolutie in één stadsregio. We hebben ook typische experimenteeromgevingen geconstrueerd, zoals de 'Valley' habitat, die een geschikte omgeving vormt voor geleide experimenten met op wetenschappelijke kennis gebaseerde technologische innovaties, en de 'Do-it-ourselves' habitat, die geschikt is voor bijv. bottom-up voedsel- of energie-initiatieven van bewonersgroepen. Elementen van deze habitats kunnen in vele stadsregio's wereldwijd worden aangetroffen.

De belangrijkste ruimtelijke omgevingsfactoren die het experimenteren bevorderen zijn:

- De aanwezigheid van een lokale of regionale *visie*. Een visie kan richting geven aan de gewenste innovaties.
- Het *leren* van experimenten, zoals via het verspreiden van leerervaringen en in het sociaal leren in regionale netwerken.
- De aanwezigheid van een omgeving met een *tegencultuur*. Leden van deze groepen vormen collectief een gunstige context voor het uitvoeren van experimenten via alternatieve ideeën, spiritualiteiten en levensstijlen.
- De verspreiding van kennis in lokale en regionale *netwerken*.
- *Regionale actoren*, met name de lokale en regionale overheid, die subsidie kunnen geven en experimenteerruimte kunnen bieden.
- De *cultuur* in de samenleving, zoals culturele openheid en vertrouwen. Deze factoren zijn van belang in sociale leerprocessen.

In het tweede deel van het onderzoek hebben we de aandacht verschoven naar de feitelijke verspreiding van innovaties. We hebben hiertoe de verspreiding van innovaties vergeleken vanuit de eerder onderzochte vier stadsregio's naar andere locaties.
We ontwikkelden het 'harbour' concept om aan te geven dat een combinatie van omgevingsfactoren de figuurlijke 'verscheping' van innovaties bevordert. Die combinatie bleek in alle steden van belang. Ook vonden we dat technologische innovaties makkelijker rond de wereld reizen dan sociale innovaties. De reden is dat de overgedragen kennis bij sociale innovaties waarschijnlijk een meer impliciet karakter heeft. Ook zijn deze innovaties sterker ingebed in de lokale omgeving. We vonden verder dat de innovaties niet worden gerepliceerd, maar worden 'vertaald'. Wat feitelijk reist is een deel van de innovatie, de gegeneraliseerde vorm van de innovatie of slechts een idee of inspiratie, gerelateerd aan de innovatie.

De ruimtelijke omgevingsfactoren die de verspreiding bevorderen bevinden zich voornamelijk op de lokale en regionale schaal. Het betreft:

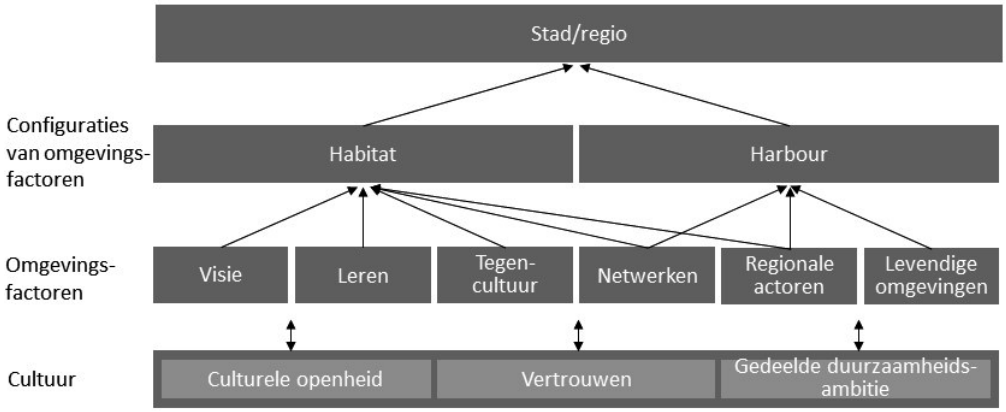
- Lokale, regionale en mondiale *netwerken* die de verspreiding van kennis bevorderen.
- Faciliterende *regionale actoren,* te weten de overheid die publiciteit kan geven aan innovaties, en de universiteit die een brede rol kan vervullen in kennisuitwisseling en leerprocessen.

- *Levendige omgevingen* zoals conferenties en festivals, waar leden van netwerken en gemeenschappen in direct contact kennis uitwisselen over duurzaamheidsinnovaties.
- De *cultuur* in de samenleving, zoals culturele openheid, vertrouwen en een gedeelde duurzaamheidsambitie. Deze factoren faciliteren de uitwisseling van innovaties, kennis en ideeën.

In het laatste deel van het onderzoek, een synthese, zijn we via een kwantitatief onderzoek in 89 regio's op zoek gegaan naar koploperregio's in Europa. Koploperregio's hebben goede omgevingsfactoren voor zowel experimenten met innovaties als voor de verspreiding van die innovaties. Ze kunnen daarmee een inspirerend voorbeeld zijn voor anderen. Er is gevonden dat koploperregio's sterk gerelateerd zijn aan steden en regio's met een hoge sociale en fysieke openheid (gemeten door multicultureel contact met mensen in andere landen, lidmaatschap van steden in wereldwijde duurzaamheidsnetwerken en internationale bijeenkomsten). Ze zijn binnen de onderzochte regio's vooral te vinden in Noord- en West-Europa, zoals de regio's Noord-Holland, Utrecht en Midland & Eastern Ireland, en soms ook daarbuiten, zoals Budapest en Catalunya.

In alle delen van dit onderzoek vonden we steeds ook dat naast de omgevingsfactoren de project-interne factoren een belangrijke rol spelen. Beide groepen van factoren dragen ongeveer in gelijke mate bij aan een succesvolle verspreiding. Met betrekking tot de project-interne factoren is de *technische kwaliteit* van de innovatie waarschijnlijk van essentieel belang voor de toekomstige verspreiding. We vonden ook dat de *vaardigheden* van de betrokkenen een belangrijke rol spelen, zoals ondernemerschap, motivatie, leiderschap en doorzettingsvermogen. Ook *communicatie- en media-activiteiten* zijn belangrijk in hun directe bijdrage aan de verspreiding van kennis over de innovatie. Publiciteit maakt het ook mogelijk dat anderen een opvolgend experiment starten, bijv. via het bieden van inspiratie.

Samenvattend is de conclusie dat de combinatie van project-interne en omgevingsfactoren de praktijkexperimenten met innovaties en de vroege verspreiding van innovaties mogelijk maakt. De omgevingsfactoren uit dit onderzoek zijn samen te vatten tot zeven groepen, zoals zichtbaar op de onderste twee lagen in de figuur. De groep van culturele factoren is onderverdeeld in drie subgroepen.



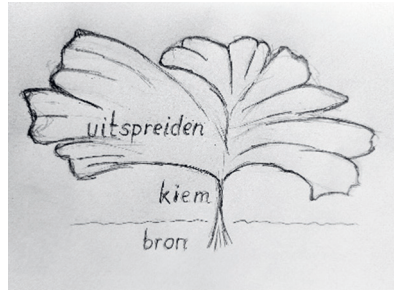
De figuur laat zien dat de groep van culturele factoren een belangrijke ondersteunende laag vormt voor andere omgevingsfactoren. Deze culturele kenmerken faciliteren de overdracht van innovaties, kennis en ideeën tussen mensen. De zeven omgevingsfactoren zijn in wisselende combinaties van belang voor het experimenteren (de habitat) en voor de vroege verspreiding van innovaties (de harbour). Veel van deze condities zijn aanwezig op de schaal van een stad of regio, maar soms ook op andere schaalniveaus. De figuur illustreert ook dat we in dit onderzoek een verbeterd inzicht hebben gekregen ten aanzien van *niches* voor duurzaamheidsexperimenten. Niches blijken meer ondersteunende factoren voor experimenteren te bevatten dan veelal werd aangenomen in de transitieliteratuur. Bovendien hebben we met dit onderzoek een belangrijke bijdrage geleverd aan de ruimtelijke articulatie van de niche.

We hebben laten zien dat de geschikte omgevingsfactoren voor experimenteren en verspreiding ontstaan kunnen zijn in de sociaaleconomische geschiedenis van steden en regio's, en ook verder gevormd kunnen zijn via een langjarig proces van experimenteren. Veel omstandigheden zijn te beïnvloeden door regionale stakeholders; ze kunnen nog verder verbeterd worden. Het proefschrift bevat een aanbeveling voor regionale netwerken om voor een specifieke groep van duurzaamheidsexperimenten de bestaande en benodigde project-interne en omgevingsfactoren ter plekke vast te stellen. We presenteren een stappenplan voor het afnemen van interviews met de pioniers en voor het houden van een actie-georiënteerde workshop. In de workshop kunnen o.a. acties worden afgesproken voor het verbeteren van de omgevingsfactoren.

Wij hebben tijdens dit onderzoek vele bevlogen duurzaamheidspioniers ontmoet, en hebben aanwijzingen dat er wereldwijd, *tussen* innovatieve niches gedeelde duurzaamheidsambities ontstaan. We hopen dat deze ambities én de inzichten uit dit proefschrift kunnen bijdragen aan een versnelling van de duurzaamheidstransitie richting een betere wereld.

Dankwoord

Hoe de grote dankbaarheid te beschrijven die ik voel, dat ik dit onderzoek heb kunnen doen en dat ik de hulp heb gehad van zovelen? En wat is het ook bijzonder om nu weer terug te kijken, en weer te ervaren hoe opgeladen ik ben door de gesprekken met die gedreven pioniers, in dit onderzoek. Het geeft me ook, uiteindelijk, de hoop voor een betere wereld.
Maar ja, bij mijn persoontje trek ik die dankbaarheid graag nog een klein stukje verder, naar de dankbaarheid die ik voel naar de mensen die mij mede hebben gevormd, tot de persoon die ik ben. Wees gerust, ik ken mijn beperkingen, ik ga geen eeuwen terug, naar de Romeinen, de Batavieren, of nog verder.
Nee, het gaat me om de iets recentere geschiedenis. En zo kom ik tot de driedeling: de **bron**, de **kiem** en het **uitspreiden**.



De bron


1966

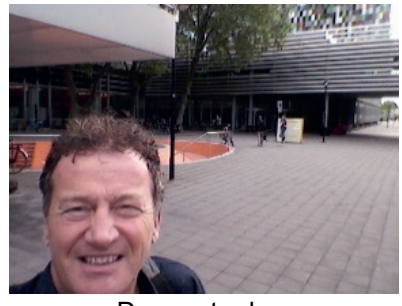
Als klein jochie werd ik gekoesterd door mijn opa Wim. Hij nam me mee op reis, op zijn brommer, en liet me de schoonheid van de Utrechtse polders ervaren, waar we gingen vissen, in Harmelen, zijn geboortedorp. Hij noemde mij ook Harmelen. Hij en zijn dochter Joke, mijn moeder, die helaas al heel lang geleden overleden is, waren mijn “vruchtbare voedingsbodem”. In de kern hebben die twee mij gevormd, met hun aandacht en liefde, en ook met hun aanpak om maar gewoon gewoon te blijven. **Wim en Joke**, ik ben zo dankbaar, het was gewoon altijd goed, als ik bij jullie in de buurt was. En ook bij **Taco**, mijn zorgzame broer, en bij wijze vader **Theo**. En bij oom **Bernard**, die me liet zien dat je ook best eigenwijs mocht zijn. Veel verder ging mijn wereld toen niet. Later ging ik studeren in Utrecht, en nog veel later ontdekte ik opnieuw dat ik een wetenschappelijke interesse had, bij het opstellen van de eerste duurzaamheidsverkenning van ons land, met de collega’s van het Milieu- en Natuurplanbureau. Een fantastisch project, voor mij persoonlijk behoorlijk zwaar. **Klaas van Egmond**, erg fijn dat je mij de kans hebt gegeven om dit project te doen. Er begon iets te broeien.

De kiem


Studium Generale

Het doorbraakmoment moest komen, en deed zich voor in 2013. **Marko Hekkert** stond op het podium van Studium Generale in Utrecht, en ik stond naast hem, als duurzaamheidsadviseur van de provincie Utrecht. Hij was pessimistisch over de snelheid van transities in de wereld, ik was optimistisch over al die Utrechtse kiemen van vernieuwing. Wat een mooi samenspel! Marko, wat ben je een fijne promotor. Je bent altijd heerlijk kritisch; bij jou heb ik geleerd gewoon erg te genieten van kritiek. En als ik dan eens een keertje vastgelopen was, dan toonde je je andere kant. Je was dan echt persoonlijk betrokken, daar heb ik veel aan gehad.

Op het provinciehuis in Utrecht, waar ik toen werkte, bleef het aan me trekken, die wetenschap. Ik vertelde aan iedereen die het horen wilde hoe leuk het was geweest, daar bij Studium Generale. Kort daarna vroeg mijn directeur, **Richard Andringa**, of ”dat niet iets voor mij was, dat promoveren”. Zo bijzonder! Ik heb van dat moment geleerd dat je omgeving zich naar je kan vormen, als je iets heel graag wilt. Een soort co-evolutie dus. Richard, wat mooi dat je namens de provincie Utrecht, samen met **Willem Wieseman** van de provincie Gelderland mij de kans hebt geboden om dit onderzoek te doen.


De eerste dag

En daar ging ik dan, de eerste dag naar de Uithof in Utrecht. Alsof ik weer student was! En de dag daarna naar Arnhem, om mijn blijdschap aan Willem te tonen. Onderweg kwam ik in een winkelstraat een opschrift tegen. Hmmm… dacht ik, is dat niet interessant? Frontrunners?

Inspiratie

Het uitspreiden

En toen, de vleugels uitspreiden, de wijde wereld in. Respondenten zoeken en verhalen verzamelen. Voor het eerste artikel heb ik gewerkt met een geweldig fijne groep studenten. **Jur de Wit**, **Jelle van Miltenburg**, **Maria Derks**, **Robin Teeken**, **Ronald van Ginkel**, **Joeri Posma**, **Koen van Aalten**: dank voor jullie enthousiasme!


Boedapest

Karlsruhe


Valencia


Toulouse

Toen zelf op stap, naar vier steden in Europa. Dit gedeelte van het onderzoek was enorm enerverend. Ik ben dankbaar naar **alle pioniers** die ik heb gesproken: jullie bevlogenheid, de tegenwerking die jullie voelden, de spanning of het wel goed zou gaan, en jullie enorme zelfbewustheid, dat hadden jullie allemaal. Het voelt heel kostbaar dat ik jullie heb ontmoet. My special gratefulness is for **Tamás Koltai** and **Erika Karman** in Budapest**, Sarah Meyer-Sohlu** in Karlsruhe, **Vicent Clemente** in Valencia and **Kerry Gamon** in Toulouse. You have received me in your town, and introduced me in your fascinating sustainability networks. Thanks a lot!

En dan, speciaal voor het afsluitende actie-onderzoek, kwam **Jifke Sol** helpen. Zo bijzonder dat we dit samen hebben gedaan, Jifke. Met jou heb ik ontdekt hoe fijn het kan zijn om in een duo te werken. Thanks.

En dan weer naar huis, voor weer een gesprek met mijn begeleiders. Beste begeleiders, we hebben heel wat gesprekken gehad, misschien kregen jullie soms wel een beetje genoeg van mij. **Gaston Heimeriks**, tsjonge, wat een toewijding heb ik bij jou gezien! En immer methodisch streng, maar nooit streng op de persoon. **Frank van Oort**, met jou herinner ik me vooral die twee geweldige middagen in de zomer van 2021, samen achter het scherm met heel veel data. Wat heb ik veel aan je gehad, en wat een fijne vent ben je. Tsja, en dan jij, **Rob Raven**. Jij hangt een beetje boven dit hele proefschrift, en je kijkt naar beneden, en je ziet dat het (bijna) goed is; ik heb je wel eens gekscherend de godfather van dit onderzoek genoemd. Je warmte, in combinatie met je tolerantie, heb ik bijzonder gewaardeerd.

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Ik kwam in de eindfase. Het ging nu ook over de vorm. **Hans Gommer**, superfijn dat je voor mij een paar prachtige illustraties hebt gemaakt. Je bent een bijzondere gast; de ‘Makerspace’ is helemaal jouw habitat. En van de vele vrienden die mij steunden, wil ik vooral **John van den Hof** bedanken. Altijd als wij elkaar zagen, was je oprecht geïnteresseerd in wat ik nu weer had gevonden.

Terug naar de bron
Vermoedelijk zijn veel processen in ons leven cyclisch; je komt naar verloop van tijd letterlijk of figuurlijk weer terug op plekken waar je eerder was, vaak gelouterd. In dit dankwoord kom ik figuurlijk terug bij mijn liefsten, **Bernard**, **Joris** en **Anja**.
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About the author

Harm van den Heiligenberg MSc. (1959) studied physical geography at Utrecht university in The Netherlands, with a specialisation in Cartography.

For several years, he worked as an environmental researcher at the Netherlands Environmental Assessment Agency (currently Planbureau voor de Leefomgeving). He was the project manager of the first Sustainability Outlook of the Netherlands, a large-scale project, investigating whether the current quality of life in The Netherlands can be continued in the coming decades. He discussed the results with national political leaders and various stakeholders.
He also widened his geographical scope towards Europe, and contributed to several long-term outlooks for the future of the European rural areas, such as the EURURALIS project.

From 2008 onwards he works as a strategy advisor at the Province of Utrecht in the Netherlands. In close cooperation with colleagues and regional partners he conducted the development of an integrated long-term strategy for the region, called Utrecht2040. This strategy has a focus on sustainable development and maintaining the attractiveness of the region. In this strategy a transition approach was introduced. With a colleague he presented this strategy on a global sustainability conference in New York, and discussed the results with experts from the United Nations.
Currently, his work at the province focuses on innovations for sustainability. He is interested in the conditions that enable pioneers in the Utrecht region to experiment successfully with innovations, and in the support needed for their upscaling ambition. He applies transition thinking in a variety of policy fields, such as the energy transition, the circular economy, climate adaptation and a healthy living environment. In close cooperation with students, he develops an innovative method to assess the transformative potential of circular initiatives in the region. He organises discussions on transition topics with colleagues, regional stakeholders and students, and gives lectures and a ‘çrash course’ on regional transitions.
To get more insight in the conditions for growth and scaling of sustainability experiments he returned to Utrecht university in 2014 to start a parttime PhD research, of which the results are presented in this dissertation.

Besides his professional occupation Harm is an ambassador of the “Transitiemotor”,

which is a national and regional sustainability community, and he was a co-organiser of Springtij, a sustainability festival in The Netherlands. Here, he coached a group of Young Innovator students. Between the sand dunes they gave a performance on ‘stories of fear and hope’ in (post-)corona times, together with Harm.

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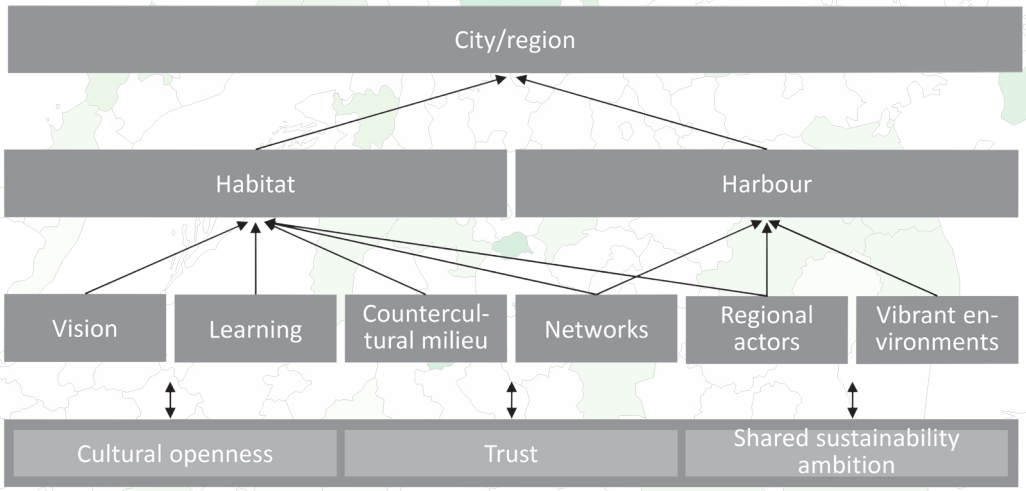
The urgency of the global sustainability challenge requires a fundamental system change: a transition of the systems, e.g., for the provision of energy and food. The transition studies literature suggests that this fundamental system change starts small, for instance, in practice-based experiments with innovations in local contexts. Would certain districts, cities or regions offer better context conditions for experimentation than others?

We developed the habitat and the harbour concept to suggest that combinations of context conditions enable experiments with innovations and the early diffusion of innovations. These conditions, shown in the figure, are mainly present on local and regional scales.



Several context conditions can be further improved. This dissertation contains a roadmap for regional stakeholder networks to assess the conditions on site. We hope that the insights from this dissertation contribute to an acceleration of the sustainability transition towards a better world.