

The Role of Urban Living Labs in Fostering Sustainable Cities – Insights from Sweden

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Abstract

Cities face growing pressures from increasing populations, giving rise to environmental and social problems. The transition towards more sustainable urban areas has thus become an urgent matter, demanding innovative solutions and means to test and deploy them. Urban Living Labs (ULLs) have emerged as a new approach to experimentation in real-life city settings. This thesis seeks to examine how ULLs can contribute to sustainability transitions by examining their goals, visions, operations, and evaluation.

The contribution of ULL to sustainability transitions is assessed via mapping ULLs in Sweden and analysing four in-depth ULL case studies (i.e. UbiGo, Hållbarheten, Shape Your World, and Fabriken) through the lens of Transition Management.

This study finds that the goals and visions of ULLs vary greatly, and that their contributions to sustainability can be either direct or indirect, both playing an important role in transitions. Furthermore, the ways in which the ULL evaluation is performed as well as what aspects are evaluated differs between the ULLs. A higher number of actors involved in ULLs can catalyse sustainability transitions due to a broader spread of knowledge reaching further into several domains of society.

In addition, this study reflects on the importance of user involvement and their ability to impact ULL operations, how ULLs fit into the Transition Management Cycle, and how requirements set by funding bodies might affect the learning produced in ULLs.

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1. Introduction

1.1 Background and Problem Definition

Sustainable development of cities is becoming an increasingly pressing matter. Cities face a number of pressures both environmental and social, forcing them to adapt and find new solutions addressing these problems. As urban areas concentrate activities that produce emissions, they also suffer from the resulting negative environmental consequences in the form of air pollution, water shortages and increased flooding and alike (Evans & Karvonen 2011). The problems are expected to magnify in the near future due to an anticipated increase of urban population. The number of people living in urban areas is already high, with almost 3/4 of European citizens living in cities, but that ratio is expected to increase to 80% by 2020 (EEA 2009). That presents a big challenge since a growing population puts increased pressure on vital city infrastructure like transportation, water supply, and power production (EEA 2009). To handle an increasing population and environmental pressures, as well as dealing with already existing social problems such as segregation, poverty, safety and security, cities must adapt and transition towards a more sustainable state. However, for this to happen long term strategies need to be developed (Loorbach 2010).

To facilitate transitions towards more sustainable urban areas, methods for governing cities in this direction need to be tested and deployed (Loorbach 2010). Cities themselves play an important role in this as they can act as test beds for new solutions and in that way generate usable knowledge (Evans & Karvonen 2014). Urban experimentation is already taking place all over the world to innovate and test new governance strategies for sustainable development (Bulkeley & Castán Broto 2013). One such approach is the Urban Living Lab (ULL) - an approach to gaining experience by testing complex solutions for sustainability in a real life context (JPI Urban Europe 2013).

The purpose and methods of ULLs vary widely – for example, labs may seek to improve the services and infrastructure in cities, or test new approaches of urban planning that involve users in an innovative manner (Juujärvi & Pessa 2013; Voytenko et al. 2015). The ULL concept covers a range of different experimental activities, including tests of new transportations systems, data collection and analysis of innovative housing, testing of tools to engage citizens in urban planning, and development of sustainable city districts.

Despite increasing numbers of ULLs, there is still a lack of understanding of their effectiveness and methodology (Franz 2014) and it is unclear whether they contribute to transitions towards more sustainable cities in a substantial way despite holding great

promise (Bulkeley & Newell 2010). Even though evaluations of some ULLs have been done, these have mainly been done by actors involved in the labs, and the academic literature on the topic remains relatively scarce. Consequently, there is a need for mapping existing ULL initiatives and to compare and contrast them to investigate their potential for contributing to sustainability transitions.

1.2 Purpose and Research Questions

As stated in the previous section, the role of ULLs in transitions towards sustainable cities needs to be further understood. The aim of this study is therefore to give an overview of existing ULLs with a sustainability focus and their characteristics to enhance the knowledge within the field. Furthermore, the aim of the study is to investigate how ULLs contribute to transitions towards more sustainable cities. The main research questions of this study is:

- How can ULLs contribute to sustainable transitions in cities?

To answer the overarching research question it is of value to understand the goals of sustainability focused ULLs, if their activities contribute to achieving these goals, and if they are evaluated in some way, and if so how. The following sub questions are therefore used to guide the investigation seeking to answer the main research question:

1. What are the goals and visions of ULLs and how do they evolve over time?
2. How do the operations of the ULLs contribute to the achievement of their goals and visions?
3. How do ULLs evaluate their activities and achievement of goals?

This study also seeks to contribute to the newly launched European research project “Governance of Urban Sustainability Transitions: Advancing the Role of Living Labs”¹ which aims to investigate ULLs across Europe and to examine their potential to govern urban sustainability transitions.

¹ See www.urbanlivinglabs.net

1.3 Scope

The scope of the investigation is limited to ULLs that potentially could contribute to sustainable development of cities either directly or indirectly. All included ULLs have some environmental aspect - some with a primary focus on environmental sustainability (e.g. energy efficiency, low emission transportation) and others with a primary focus on social sustainability (e.g. democracy, security).

Furthermore, the geographic scope for the study is limited to Sweden, specifically the three biggest cities in Sweden with analysis of ULLs located in Stockholm, Gothenburg and Malmö. This to assure that the labs examined are set up in an urban environment and focus their efforts on sustainable development of urban areas. Hence, the labs with a focus on rural areas were not included in the investigation.

1.4 Disposition

Chapter 1: Provides background, introduces the problem addressed in this thesis and the research questions. The thesis outline and scope is described.

Chapter 2: Gives an introduction to urban living labs and presents different definitions of the concept. Describes the theory of transition management and the transition management cycle (TM cycle) and explains the relevance of transition theory for examining ULLs.

Chapter 3: Presents the research design and methods used for data collection and analysis of the findings. Methodological limitations of the research are indicated.

Chapter 4: Presents the main findings of the ULL mapping and the four cases studies.

Chapter 5: Presents an analysis of the findings guided by transition management theory, investigating each of the three sub-question of the thesis.

Chapter 6: Discusses the findings, their significance, and reflects on the overarching research question in the light of the analysis of the sub-questions. Considers the applicability of the methodology and theoretical perspectives used in the thesis.

Chapter 7: Presents key conclusions and provides suggestions for further research areas to enhance the understanding of ULLs' contribution to sustainability transitions.

2. Central Concepts and Theory

In this chapter fundamental concepts underlying the thesis are presented. Section 2.1 deals with the evolution of the urban living lab and presents different definitions of the concept, pinpointing the central characteristics of ULLs. To further enhance understanding, real life examples are presented. Section 2.2 addresses transition management theory, which is later applied in the analysis to assess ULLs potential to contribute to sustainability in cities. The final section of this chapter, 2.3, relates the two concepts and explains why transition management is an appropriate framework for studying ULLs.

2.1 Definition of Urban Living Labs

Urban living labs have evolved from the initial concept of the *living lab*, a relatively new term that emerged through product testing during the 1990s to describe user-driven innovation (Markopoulos & Rauterberg 2000; Eriksson et al. 2005; Mensink et al. 2010). Initially the focus of living labs was to test technologies in a homelike constructed environment but since then the concept has expanded and the emphasis now lies on the labs being set in a real world context (Mensink et al. 2010; Stålhbröst 2008). Living labs are still used for testing products and services, but the concept has evolved and living labs are now also used for urban research and involvement of citizens in decision-making processes of urban development (Franz 2014; Fahy et al. 2007). Many recent examples of living labs in urban areas also focus on the implementation of smart technology with the purpose of creating more resource efficient and low carbon cities (Evans & Karvonen 2011; Franz 2014).

Living labs bear similarities to participatory design processes that have been used for several years in IT development and product design (Stålhbröst 2008, Westerlund & Leminen 2011). However, living labs aim not only to produce technical innovation but also foster civic involvement and co-creation (Franz 2014). Recently living labs have been used to actively engage citizens in urban research projects with socially oriented research agendas (Franz 2014). The concept of living labs now covers a variety of projects related to different types of development projects in cities globally, including social innovation and participatory policy development projects in both developed and developing countries (Fahy et al. 2007, Edwards-Scharter et al. 2012, Franz 2014, Bulkeley & Castán Broto 2013). Living labs are used to explore topics for urban research and to assess their relevance for

urban strategic planning by actively involving citizens in the research projects (Franz 2014).

It is clear that the definition of living labs covers a variety of experiments with different goals and approaches for reaching them, but they do have common characteristics. European Network of Living Labs (ENoLL 2015) defines a living lab as a real-life test and experimentation environment where users and producers co-create innovations, discover emerging usages, behaviours and markets. Importantly, the concepts tested in the labs are evaluated to ensure learning and progress (ENoLL 2015). Westerlund & Leminen (2011) present a similar definition describing a living lab as a virtual or a physical region in which different stakeholders collaborate to create, prototype, validate and test new technologies, services, products and systems in real-life contexts. Salter & White (2014) makes a distinction between two meanings of the term *living labs*: On the one hand, a physical space where users carry out normal activities using a new product or service while being studied to assess the effectiveness of the innovation tested. On the other hand, more commonly, networks and organisational arrangements engaging multiple stakeholders that together carry out research in a real-life context rather than a physical space.

In recent years the living labs have been used as a means for urban governance and in sustainability research (Evans & Karvonen 2011; Bulkeley & Castán Broto 2013). The term *Urban living lab* has emerged to describe living labs set up in urban areas seeking to address issues occurring there (JPI Urban Europe 2013). The funding body Joint Programme Initiative (JPI) Urban Europe defines the term as follows:

“It is a forum for innovation, applied to the development of new products, systems, services, and processes, employing working methods to integrate people into the entire development process as users and co-creators, to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex and real contexts.” (JPI Urban Europe 2013)

The real-world setting lends credibility to the results and knowledge gained from the labs. Due to the setting ULLs have a promise to produce more useful knowledge than experimentation performed under more controlled circumstances (Evans & Karvonen 2011; Reimer et al. 2012). An additional benefit of the setting is that the labs become highly visible and noticeable, which could inspire a social and technical transformation of the city or society (Evans & Karvonen 2011; Salter & White 2014). On a similar note, the learning and innovation processes of ULLs are more formalised than those of other types of experimentation seeking to innovate new policies to govern cities (Bulkeley & Castán Broto 2013), and the generation of knowledge from ULLs may therefore be more reliable.

Collaboration and involvement of the users is also considered a central element of ULLs (Voytenko et al. 2015; Schliwa 2013). The initiators and goals of labs can vary but complex partnerships consisting of actors such as universities, private actors, public bodies, inhabitants of cities etc. usually form around ULLs (Voytenko et al. 2015;

Westerlund & Leminen 2011). The labs also aim to involve users as testers of new products and services as an innovative element of development and decision making (Franz 2014). Generally, the users are people who are or would be affected by the product or service tested in the lab, lending credibility to the success of potential future applications (JPI Urban Europe 2013). They play a big part in the operation of the lab by giving feedback and being an active partner through the whole innovation process (Westerlund & Leminen 2011; JPI Urban Europe 2013). This element of ULLs gives users power and in that sense living labs could be viewed as a potential tool to deepen the democracy in urban areas (Salter & White 2014).

Like living labs, the activities of ULL experiments vary widely, representing basic research, applied research as well as innovation² (JPI Urban Europe 2013). Juujärvi & Pessa (2013) identify three main types of ULLs (Fig. 1) which are helpful to consider.

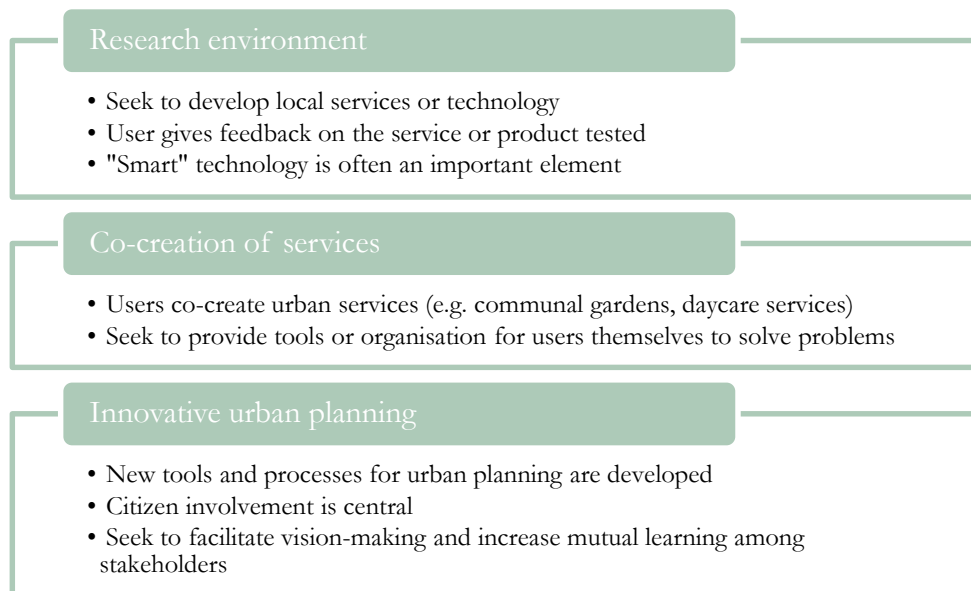


Figure 1 Three types of ULLs
Based on Juujärvi & Pessa (2013).

² As described by JPI Urban Europe (2013): Basic research answers the questions of how cities function. Applied research gives applicable knowledge of how to improve cities. Innovation puts those ideas to use towards the development and uptake of new product, service, policies, practices and processes.

Two examples of existing ULLs taken from academic literature are the *Oxford Road Corridor* in Manchester, UK and *Stadslab2050* in Antwerp, Belgium³. The Oxford Road Corridor consists of an area of 243 hectares involving two universities and five hospitals (Evans & Karvonen 2011). Local private stakeholders have together with the Manchester City Council made it their mission to improve the economic, environmental, and social aspects of the area. The area is intended to be used as a test bed for energy, communication and transportation technologies and the University of Manchester want to use the area to realise a vision of a resilient low carbon economy (Evans & Karvonen 2011). Although there is an element of engineering and technical innovation in the lab the emphasis is rather on environmental policy and urban development (Evans & Karvonen 2011), hence making it fall under the definition of a ULL. *Stadslab2050* is a ULL with the goal of making Antwerp a sustainable city bringing together public actors, NGOs, citizens, and private actors from the city to develop projects (*Stadslab2050* 2015). Since the start in 2013, *Stadslab2050* and its partners has designed and implemented 15 projects focusing on the topics green spaces in the city and sustainable living and renovation (Voytenko et al. 2015).

To summarise, characteristic of a ULL is the real-world setting of the lab, involvement of stakeholders from different sectors of society, involvement of and co-creation with the users of the lab, and formalised learning or reflection taking place in the lab.

2.2 Transition Management

As pressures on societies change, those societies respond by departing a state of equilibrium and slowly progress towards a new, alternative, equilibrium (Rotmans et al. 2001). This state of changes is called a transition. Simply put, a transition is a number of changes that reinforce each other and together impact the existing structures of society and transform them into new structures. The changes can take place simultaneously in different domains of society, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems (Rotmans et al. 2001). For transitions to occur, several different changes and developments of different domains must come together (Rotmans et al. 2001).

Transition occurs when dominant structures of society (cultures and practises) – sometimes called *regimes* – are put under the pressure by external changes in society or by innovation from within the dominant structures (Rauschmayer et al. 2014; Loorbach 2010). New initiatives operating at a smaller scale than dominant regimes are called *niches*. Upcoming niches have the potential to spread and with time become new regimes or

³ More examples of existing ULLs can be found in e.g. Voytenko et al. (2015), Evans & Karvonen (2011), Schliwa (2013), and Nevens et al. (2013).

transform existing dominant structures. Transitions are thereby associated with a power struggle between dominant regimes and upcoming niche initiatives (Avelino & Rotmans 2009) and changes of the structure of societies often come about as a result of individual actions responding to changing societal conditions (Loorbach 2010). Surrounding the niches and regimes is the *landscape* represented by the global trends or norms affecting the societies and thereby also the regimes and niches within these societies (Rip & Kemp 1998). Rauschmayer et al. (2014) illustrate the difference between landscapes, regimes and niches with an example:

“German community energy initiatives (niches) multiplied and expanded drastically after the Fukushima nuclear melt-down (landscape level), mostly due to an institutional change initiated by the governmental decision to enter a phase of large-scale energy transition (regime level).” (Rauschmayer et al. 2014)

Transition processes are not uniform as they can differ in scale of change and the period over which the change occurs (Rotmans et al. 2001). Generally, a transition is a long term process consisting of periods of both slow and fast development with processes commonly spanning over at least a generation (25 years) (Rotmans et al. 2001).

Even though transition processes differ widely in time and scale, they share common characteristics. Transitions are generally divided into four distinct phases: the *predevelopment phase*, the *take-off phase*, the *breakthrough phase* (sometimes called the *acceleration phase*), and the *stabilisation phase* (Fig. 2) (Rotmans et al. 2001). The characteristics of the phases are described by Avelino & Rotmans (2009). During the predevelopment phase changes occur at a niche and landscape level and do not affect the dominating regimes to a great extent. In the take-off phase the process of change gains momentum and the pressure on current regimes increases and starts to break down or shift. Later the breakthrough phase follows in which the structural changes become visible as old regimes are being replaced by new structures. Rotmans et al. (2001) describe the structural changes taking place as an accumulation of socio-cultural, economic, ecological, and institutional changes reacting to each other. During the stabilisation phase the spread of the change decreases, and a new regime replaces the old regime, and a new equilibrium is reached (Rotmans et al. 2001; Avelino & Rotmans 2009).

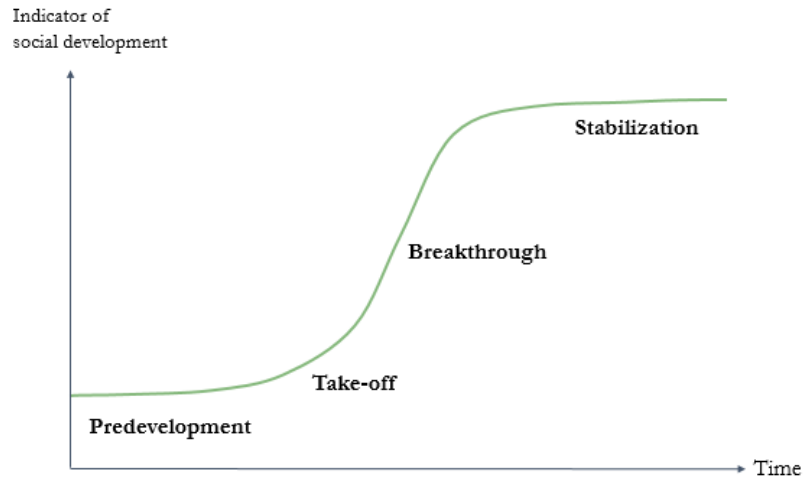


Figure 2 The phases of transitions

Based on Rotmans et al. (2001).

Transition management theory gives an explanation of how transitions occur and therefore builds knowledge for pathways to govern the transition process. The theory has its roots in system thinking and seeks to provide a better understanding of the complexity of societies and governance (Loorbach 2010). The governance and interactions of societies are complex and not sufficiently explained by the models of top-down and bottom-up governance (Loorbach 2010). Understanding the patterns and mechanisms of transitions enables for better analyses and opportunities to influence the process. That possibility of directing development makes transition management theory suitable to be applied for governance towards sustainability (Kemp et al. 2007; Loorbach 2010). Achieving sustainability is a continuous process requiring an open and adaptive governance strategy which focuses on learning and experimentation (Kemp et al. 2007) furthering the case that transition management theory is useful to model the process.

The core of the theory is the acknowledgement of the presence of multiple actors at different levels of society working in various domains, who together bring about changes and thereby also societal transitions (Rotmans et al. 2001). By knowing how the activities of actors at different levels influence each other and how the actors themselves collaborate, the changes can be organised so that they align and reinforce each other, creating transitions (Kemp et al. 2007).

Four core governance activities of transition management have been identified: *strategic*, *tactical*, *operational* and *reflexive* (Loorbach 2010). The interaction between them can roughly be described as a cyclical process (Fig. 3), however the cycle has no clear beginning or end and there are often overlaps between the categories of activities since each one affects the others (Loorbach 2010). This framework has previously been applied to study living labs and understand their contributions to sustainable urban transitions (e.g. Schliwa 2013).

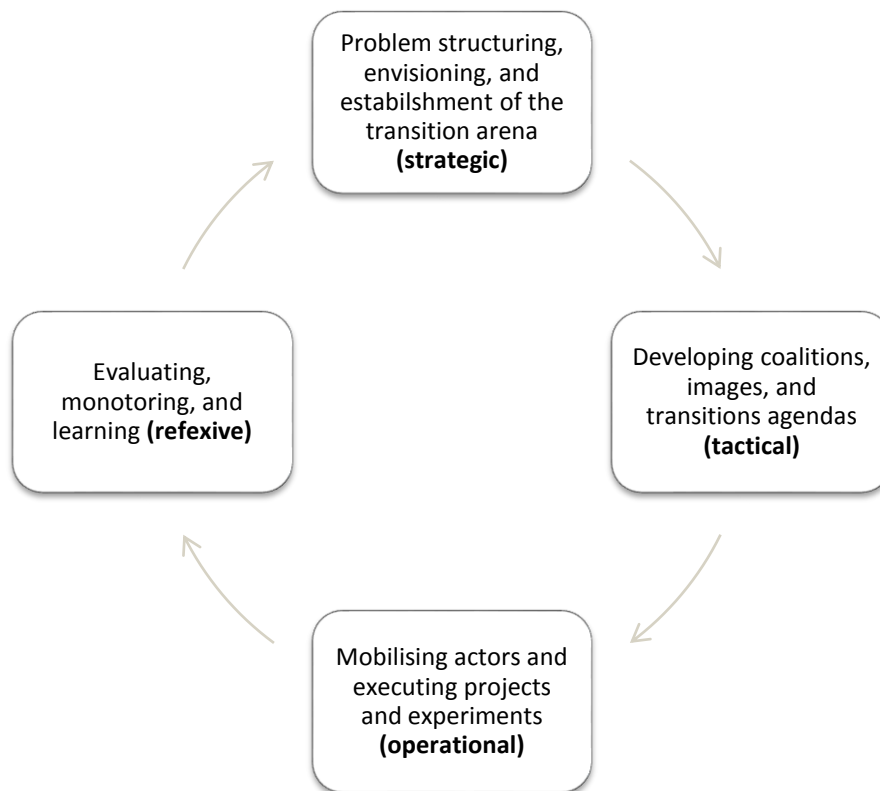


Figure 3 The transition management cycle
Based on Loorbach (2010).

Strategic activities are processes of vision development and long term goal formulation. This is done by the *transition arena* which consists of a network of societal actors, preferably 15-20, with various views of the transition issue in question and different backgrounds (Loorbach 2010). The actors should come from a variety of societal groups, distributed evenly between governmental bodies, companies, NGOs, knowledge institutes (e.g. universities, research centres) and intermediaries (e.g. consulting organisations, project organisations and mediators) and be “frontrunners” but not necessary experts on the issue in questions, they could also be opinion leaders or networkers as well (Loorbach 2010). Together they discuss an issue that might require transition. They discuss current and anticipated trends of the issue and debate possible solutions to address the issue. This process is generally not systematic, but rather a dynamic and subtle process of merging opinions sometimes lasting as long as 30 years (Loorbach 2010).

The visions act as a starting point for transitions and form a common ground for discussion, action and collaboration. However, the visions can change during the process.

As actors come and go or the knowledge of the issue improves, new ideas form and the visions may be adapted and reformed (Rotmans et al. 2001). This is a vital part of the envisioning taking place and contributes to the success of the process. The vision forms the basis for the creation of a *transition agenda*. A transition agenda is more concrete than the visions. It contains joint objectives, actions that could contribute towards the envisioned future and defines the actors' responsibilities and planned projects (Loorbach 2010).

The transition agenda is a part of the second core group of activities of transition management – the *tactical activities*. The focus of these activities is to establish structures such as networks, rules, institutions and infrastructures in line with vision of the transition (Loorbach 2010). Here the interventions happen on the regime level, where current structures of societies are affected and changed (Loorbach 2010; Wiek et al. 2006). The overall vision is broken down into objectives, which can be achieved with a number of different interventions. Possible combinations of actions and interventions to reach the vision are called transition paths (Loorbach 2010; Rotmans et al. 2001). The actors involved in this part of the process initially constitute a small number of innovators and strategic thinkers from different backgrounds, but further on in the process networks are formed that bring a more diverse group of actors (i.e. local authorities, NGOs, knowledge institutes, and intermediaries) together to develop new transitions paths (Loorbach 2010; Pisano 2014). However, the actors involved in the tactical activities are generally not too concerned with the overall vision itself, focusing rather on their own activities and the sub-area of society they operate in e.g. on developing new technology without focusing on behaviour change (Loorbach 2010). The actors can view their objectives as strategic on an individual level, even though they are seen as tactical activities in transition management theory. Generally tactical activities and the development of transition agendas take 5-15 years (Loorbach 2010).

The third core group of activities includes the *operational activities*. Experiments are carried out to test and broaden planned initiatives, in other words, testing different transitions paths (Loorbach 2010). Sometimes the experiments are developed from the vision and transition objectives, but are often established without such a systematic approach – instead, experiments already taking place can be linked to the transition arena and the transition agenda (Rotmans & Loorbach 2008). Experiments occur at a niche level and are often driven by individual ambitions, not by the overarching transition goals (Loorbach 2010). The experiments linked to a transition can vary widely, sometimes competing with and other times complementing each other (Loorbach 2010).

An experiment deemed successful after evaluation of its learning experience and contributions to the transition challenge can be repeated in different contexts and scaled up from the micro-level it has been operating on into a mainstream option (Rotmans & Loorbach 2008), where it may transform societal structures. However, this requires time – approximately 5-10 years (Loorbach 2010).

The fourth core group of activities are the *reflexive activities*, which encompass monitoring and evaluation. During the whole process of transition, evaluation and

monitoring should take place - both of the transition process itself and the transition management process (Loorbach 2010). Many aspects can be monitored to facilitate the learning process of transitions - the behaviour of the actors of the transition arena, the transition agenda, fulfilment of goals and visions, as well as the experiments and the knowledge they yield (Loorbach 2010).

Continuous evaluation and monitoring of the transition may result in collective learning due to the interaction between different actors, and inspire a common reflection and further development of the whole transition process (Loorbach 2010). It is important to point out that the purpose of transition management is not simply to realise that a transition is needed and to achieve that needed change - the main purpose is rather to learn and work towards a transition in an open manner (Rotmans et al. 2001). Transition management is a way to improve the collective learning and the exploratory aspects of the approach allows for the visions to be adapted based on the knowledge gained (Rotmans et al. 2001).

2.3 Relevance of Transition Management to Urban Living Labs

As mentioned above, the overall rationale behind ULLs is to address urban issues and test new solutions. If those solutions spread outside of the initial lab, they could come to affect societal structures in a meaningful way. This could be seen as a niche initiative growing in size to eventually influence the regimes surrounding it. However, whether ULLs cleanly fit in to the role of niches is not clear. ULLs could also be seen as a mix of niches and regimes, since the ULLs to some extent are affected by regime level forces such as politics and societal trends (Bulkeley & Castán Broto 2013).

Transition management explains how changes in social structures occur, and what the role of experimentation and niche initiatives in these transitions is. ULL activities closely mirror the operational activities of the TM cycle. The goals and visions of ULLs could be seen as a part of the transition agenda developed in the tactical phase of the TM cycle, which in turn is a product of the discussions taking place in the strategic phase of the cycle. Like the visions of transitions, the visions of ULLs tend to change due to the real world context they operate within (Friedrich et al. 2013). Evaluation and learning also plays a central role in both transition management and ULL-methodology and evaluations of and learning from ULLs can be seen as part of the reflexive activities which is crucial to the TM cycle.

This is not the first time transition management has been applied to analyse ULLs from a sustainability angle - Schliwa (2013) used the TM cycle to understand living labs in practice and concluded that transition management theory provides a helpful analytical framework. This thesis proceeds from that point and investigates: given that transition management is applicable to examining ULLs, what does it reveal about their ability to

make contributions to sustainable development. Specifically, by investigating whether ULLs match the criteria for a successful transition experiment this thesis examines their potential to contribute to sustainability transitions. See section 3.1.3 for a more detailed description of how transition management was used to examine ULLs in this study.

3. Methodology

In this chapter the research design and methods used for data collection and analysis are presented. Section 3.1 and its sub-sections explains how the research was performed and the motivation behind the research design choices. Section 3.2 points out the methodological limitations of the thesis, both conceptual and practical.

3.1 Research Design

The investigation to answer the overall research question and research sub-questions consisted of an initial mapping of ULLs in Sweden followed by in-depth case studies. Four of thirteen ULLs mapped were chosen to be included in a multiple case study to deepen the understanding of the role of ULLs for sustainability transitions in cities. The case analysis was informed by the transition management theory, which guided the exploration of how they might contribute to sustainability. The study used qualitative research methods which are well suited for developing an understanding of a phenomenon, its causes, and its context in the form of its actors and processes (Maxwell 2005).

3.1.1 Mapping Urban Living Labs

To identify relevant cases of ULLs with a sustainability focus a mapping of existing ULLs in Sweden was done. The labs were found by sifting through the European Network of Living Labs' (ENoLL)⁴ database of living labs and the website of JPI Urban Europe⁵, combined with searches in Google using the words: *urban living lab*, *living lab*, *living laboratory*, *urban transition lab*, *city lab*, *urban experiment*, and *urban laboratory* in combination with words meant to limit the location of the lab: *Sweden*, *Malmö*, *Stockholm*, and *Gothenburg*. Additionally, referrals from researchers in the field was a key source for identifying ULLs. To determine whether the labs found were relevant for the research information on the labs was found on the homepages of the labs and their funding bodies.

⁴ See <http://www.openlivinglabs.eu/livinglabs>

⁵ See <http://jpi-urbaneurope.eu/>

In some cases, the lab actors were contacted in-person to gain further understanding of the labs' characteristics.

To give an overview of the identified ULLs and their characteristics, location, geographic scale, main focus (e.g. mobility, energy, urban planning, community uplifting, etc.) and time the lab was or is planned to be active for were listed. If the labs were found to be part of ULL networks the networks in question were listed too. For all labs the actors involved in the lab operation or development were identified.

Additionally, the driving actors (e.g. initiators, owner or managers) of each lab were identified. The terms *utiliser-driven*, *enabler-driven*, *provider-driven* and *user-driven* as presented in Leminen et al. (2012) was used to categorise the driver of the labs:

- An *utiliser-driven* lab is set up by a company in order to develop their business. The focus is to test and develop products and services by collecting information from users of the product or service for business development.
- An *enabler-driven* lab is driven by public-sector actors, NGOs and financiers. These labs are typically set up to improve the society and to build on regional and societal needs, e.g. reduce unemployment. It is not uncommon for universities and other educational bodies to be involved as a supportive actor, but involvement of companies is unusual.
- A *provider-driven* lab is set up by universities, other educational institutes, or consultants. This type of lab focuses on research development and generating knowledge for actors involved in the lab.
- A *user-driven* lab is usually established by the users themselves to find solutions to everyday problems. These labs are often long lived due to them being built around an already existing community. Even though users drive the lab they generally do not manage the operation. Instead, the operation is facilitated by a provider and the activities are supported by actors connected to the labs. (See table 1 for an overview.)

Table 1 Characteristics of different types of living labs

Based on Leminen et al. (2012).

	UTILISER-DRIVEN	ENABLER-DRIVEN	PROVIDER-DRIVEN	USER-DRIVEN
DRIVER	Companies	Public sector (e.g. municipalities) NGOs Financers	Universities Knowledge centres Consultants	Users (e.g. housing communities, hobby groups)
AIM	Test and develop products/services. Business development.	Improve society, build on regional and societal needs.	Research development. Test research theories, operation development.	Find solutions to everyday problems.
LIFESPAN	Short	Short/medium/long	Short/medium/long	Long

3.1.2 Developing Case Studies

Following the mapping process, the four ULLs were selected to be included in a multiple case study. Case study research is a suitable approach to use when studying new phenomena that have not been studied to a great extent as well as for answering how- and why- questions (Yin 2014; Eisenhardt 1989). Multiple case studies have the advantage over a single case study as they offer the research a fruitful ground to examine similarities and differences between the cases (Meyer 2001). However, the number of cases can be fairly few since the purpose is to provide a deeper understanding of the concept studied (Mayer 2001). Since the aim of the research is to study how ULLs might contribute to transitions of cities in general, a multiple case study is considered appropriate with four cases allowing for a rather rich cross-case comparison.

The evaluations and the operations of the labs were central to the study (as indicated by sub questions 2 and 3). Therefore mature labs that had been finalised or had been ongoing for a sufficient amount of time (at least a year, but preferably longer) were possible candidates for the case studies as they allowed for reflection on their operations and success. Consequently, labs in the planning phase or the initial stages of operation were not selected for in-depth study in this research. The labs selected operate at a different geographical scale and represent all four driver types presented by Leminen et al. (2012) (see table 2). This offers a variety of perspectives to be analysed. All four selected cases focus on developing or facilitating solutions for sustainability - two with a clear focus on environmental sustainability, and two with a more prevalent focus on social sustainability yet still incorporating environmental sustainability in the operations.

Table 2 Selection criteria for cases examined in this study

	UBIGO	HÅLLBARHETEN	FABRIKEN	SHAPE YOUR WORLD ⁶
DRIVING ACTOR	Provider-driven	Utiliser-driven	User-driven ⁷	Enable/provider-driven
GEOGRAPHICAL SCALE	City	Building	Building	City district

⁶ Shape Your World is one of three living lab in the SubUrbanLab project. The other two were not finalised at the time of the case selection. They are included in the mapping, but were not chosen as case studies.

⁷ While the operation of Fabriken's host organisation was initiated by a provider, it was given free reins and its activities, including Fabriken, were developed in co-creation with the users (see specifics in chapter 4).

For case studies a mix of methods for gathering information is often used (Eisenhardt 1989; Darke et al. 1998). When a variety of data sources or methods are used to examine and produce more accurate account of a phenomenon, a *triangulation* is performed, which ensures that different perspectives and multiple angles are gathered on the phenomenon under investigation (DAC 2002). Triangulation of methods and data sources was applied to the multiple case study in this research, i.e. a combination of stakeholder interviews, documents published by the labs, homepages of the labs, home pages of third party organisations (e.g. funding bodies, network organisation of living labs), research project related documents (e.g. working papers, reports, presentations), visits to the labs and scientific articles about the labs and their operations were used to gather information.

The work employed semi-structured in-depth stakeholder interviews. This is recommended for multiple case studies since it gives some structure to the interviews making it easy to compare and contrast the cases (Bryman 2012). In addition, semi-structured interviews offer a possibility for the respondent to answer quite freely and for both the respondent and the interviewer to follow up on what is being said during the interview, in contrast to a more structured interview where the discussion about the subjects covered by the questions is not as free (Bryman 2012). The interviews were conducted using an interview guide (see appendix 1 and 2) consisting of questions on themes delivered from the sub-research questions as well as more general questions about the lab and the interviewee. The questions centred on the background of the labs, activities of the labs, actors involved, the establishment and the activities of the labs, purpose and evaluation of the labs, and whether the concepts and advances of the lab have spread. Before using the interview guide for stakeholder interviews, the guide was tested and peer reviewed to ensure the questions were easily understood and suitable for their purpose.

The people contacted for interviews were those listed as having roles of responsibility within the ULL projects on the ULL homepage, publications by the ULLs or its funding body. Some were identified through referrals by researchers, and others through referrals from previously contacted stakeholders, i.e. using the snowball technique (Bryman 2012). Researchers collaborating with the ULLs, project leaders of the labs, and representatives of municipalities were among the people contacted and interviewed. A list of all interviewees and their positions can be found in appendix 3.

Some of the interviews were held in person while others were performed over the phone (see appendix 3). Each interview was performed with the informed consent of interviewee and recorded with their permission. The interviews were then transcribed, fully or partially. If an interviewee wished to read the transcripts and approve of their name being used in the study they were given the opportunity. In addition, notes were taken during the interviews to help keep the track of whether all questions in the interview guide had been answered and to help formulate follow-up questions.

Quotes of the interviewees were used in the thesis to highlight specific information obtained from the interviews. All interviews were held in Swedish, and all quotes presented were translated to English.

A literature review of the cases was done before performing the interviews, as well as throughout the research process to supplement the analysis. Homepages of the ULLs and actors involved in the ULL projects, evaluations and reports on the ULLs, and a PhD dissertation on one of the cases were utilised to gain information. These included both the documents published by the ULLs themselves as well as by other actors involved in the labs, such as universities involved in the evaluation of the labs, and third party publications. The cases located in Malmö were visited, which contributed to building a comprehensive understanding of the activities of the labs.

3.1.3 Data Analysis

Transition management theory and the TM cycle (see chapter 2) form the basis for the in-case study analysis and function as an analytical framework. The framework provides an understanding of how sustainability transitions can come about and be managed and explains the role of experimentation. The selected cases were all studied from the perspective of transition management, compared and contrasted to understand their potential to contribute to sustainability transitions. Rotmans et al. (2001) list four possible criteria for evaluating experiments within the transition framework - two of which were relevant for the research questions and scope of this thesis. Those two criteria were guiding for the case analysis.

Firstly, Rotmans et al. (2001) define a successful experiment as the one offering possibilities for innovation and for transition paths to be explored through the lab activity. The vision and goals of ULLs, and the lab activities alignment with those is thereby central for understanding how a ULL could contribute to transitions and what transition path the lab explores. The investigation to answer sub research question 1: *What are the goals and visions of ULLs and how do they evolve over time?* and sub research question 2: *How do the operations of the ULLs contribute to the achievement of their goals and visions?* were used to examine whether this was the cases for the ULLs selected for case studies.

Secondly, for experiments to contribute to sustainability transitions they need to contain the potential for learning (Rotmans et al. 2001). To examine if the ULLs selected for the case studies do that, the investigation of sub research question 3: *How do ULLs evaluate their activities and achievement of goals?* was used to study how the ULLs were utilised as opportunities for learning. If the evaluation of lab activities took place, it was viewed as a means to gain formalised knowledge from the ULL and the aspects that were evaluated were used as an indication of what type of knowledge was gained from the lab. A summary of the method used to analyse the selected cases can be found in table 3.

Table 3 Overview of method used for case analysis

CRITERIA FOR EVALUATING AN EXPERIMENT'S CONTRIBUTION TO A TRANSITION	INDICATOR	CORRELATION WITH RQ
Possibilities for innovation and transition paths explored through the experiment.	Vision/goals of the ULL.	RQ1
	Issue the ULL tries to address.	RQ2
	Alignment of vision/goals and lab activities.	
The experiment and its activity contain the potential for learning.	Aspects of the ULL being evaluated and monitored.	RQ3
	Use of evaluations.	

3.2 Methodological Limitations

The data collection was constrained by the availability of relevant stakeholders of the ULLs investigated. Besides that, the academic literature on the topic of living labs for sustainability is still relatively scarce. There have been a number of case studies and evaluations done on ULLs but these are mainly done by practitioners of the ULLs. The knowledge on the ways in which ULLs contribute to sustainable development is limited and fragmented.

The conditions for the case studies differed from case to case. It was not possible to visit all of the cases due to the traveling distance and budget constraints, only the labs located in Malmö were visited.

The data analysis also faced both conceptual and practical limitations. In some cases it was not clear where the boundaries of a living lab were. For example, the lab HS2020 can be seen as a single living lab with many sub-projects, or the sub-projects themselves can be viewed as separate labs coordinated by HS2020 (see section 4.1). Studying the labs at different levels could yield more knowledge but for this thesis the labs were all viewed from one level. To avoid misunderstanding and to clarify how the labs were viewed, the context of the labs was explained in each case.

4. Findings

This chapter presents the mapping of ULLs in Sweden and the findings of the four case studies. Section 4.1 presents the context of the thirteen ULLs mapped and table 4 presents the full mapping. Of the ULLs mapped four labs were studied in depth i.e. UbiGo, Hållbarheten, Shape Your World, and Fabriken. The findings of these case studies are presented in section 4.2 and its four sub-sections. Table 5 gives an overview of the four cases, followed by sub-sections focusing on each of the labs.

4.1 Urban Living Labs in Sweden

To clarify the context of the thirteen labs mapped (Table 4), a brief explanation of the labs follows.

Only one co-creational lab has been identified, represented by Fabriken, the characteristics of which are presented in detail in the case study (see section 4.2.4). Like Fabriken, the lab HS2020 located in Hammarby Sjöstad is also a bottom up initiative and is driven by citizens. HS2020 is a project led by a collaboration between housing cooperatives, whose vision is to develop the city district into an ULL that acts as a research environment testing new ideas in transportation, energy, sports and culture (Evliaiti 2013). The aim is to initiate a shift of perspective where the city is seen as a constantly developing environment (Evliaiti 2013). The lab includes eight sub projects⁸, all with different key partners, of which Elbil2020 and HS2020/Energy are the most prominent, focusing on facilitating a transition to electric vehicles and improving energy efficiency respectively (Evliaiti 2013).

In addition to HS2020, several more ULLs acting as research environments were found. Some of those seek to investigate solutions for sustainable homes. Hållbarheten test energy, architecture and transportation solutions for the future home (see more in section 4.2.2), Elis uses a similar type of technology to some of the technology tested in Hållbarheten, which lets residents monitor their energy use and lower their energy consumption (Olsson 2015). HSB is a living lab in the initial stages of development. It will

⁸ The eight projects being Elbil2020, HS2020/Energi, Recycling 3.0, Water Quality, Digital Cinema, Future Hammarby Hill, Traffic Safety, Interactive ICT, Noise and Other Environmental Impact from Södra Länken, and Sustainability as Business Opportunity.

consist of student housing and is planned to act as a test bed for different types of technologies and architectural solutions to investigate resource and energy efficiency in the homes (HSB 2015). A few other labs seek to lower the environmental impact from transportation. UbiGo's research environment spans over the whole city of Gothenburg, and the lab tested a travel service offering alternatives to a privately owned car (see section 4.2.1). The project Eco-tell is in the process of developing an IT-platform to test possible solutions that aim to increase the efficiency of Swedish transportation (Viktoria Swedish ICT 2015). The Bike Library is a new initiative seeking to offer citizens of Malmö the opportunity to test electric and cargo bikes for two weeks to see if that type of bike would suit the lender as a sustainable means of transportation before deciding whether to invest in their own similar bike (Älg, K. 2015, pers. comm. 19 February).

A number of ULLs focusing on innovative ways for urban planning and engagement of citizens have also been found. SubUrbanLab is a collaboration between Finland and Sweden which runs three labs located in Sweden – Shape Your World, Vacant space Alby, New light on Alby Hill⁹ (SubUrbanLab 2015a). All these ULLs seek to enhance sustainability in less valued suburban areas, and to examine the ULL-methodology itself (see section 4.2.2). Färgfabriken is an exhibition and meeting space that functions as a platform for discussion on city development and how it can be done sustainably (Färgfabriken 2015a; Färgfabriken 2015b). The lab coordinates a few different projects¹⁰. The largest one among those is *Stockholm on the Move* focusing on the urban development of Stockholm and involving many different stakeholders in the discussions (Färgfabriken 2015b). Lastly, Malmö Innovation Platform is a lab run in a close collaboration between the City of Malmö and universities, planning to renovate apartment buildings to generate socio-economic development and build on environmental goals (City of Malmö 2015a).

⁹ The three Finnish labs Energetic Co-cooperation, Sustainable Decisions, and Together More are located in the city district Peltosaari of the city Riihimäki. More information can be found on the homepage of SubUrbanLab: <http://suburbanlab.eu/>

¹⁰ These include Stockholm on the Move, New Urban Topologies, and Experiment Stockholm.

Table 4 Compilation of ULLs in Sweden

URBAN LIVING LAB	LOCATION	SCALE	DESCRIPTION	SUSTAINABILITY FOCUS	DURATION	DRIVER	COORDINATOR	KEY PARTNERS
FABRIKEN	Western Harbour (Malmö)	Building	<u>Co-creation</u> A makers-space giving access to equipment, fostering reuse and repair.	<u>Social:</u> co-creation, democracy <u>Environmental:</u> Sharing economy, upcycling, resource efficiency	Initiated 2007, official launch 2011 - undetermined	User-driven	SPTLN	<u>Public:</u> City of Malmö <u>Private:</u> Arduino Verkstad, Iscalet <u>Researchers:</u> Malmö University <u>Non-profit organisation:</u> STPLN <u>ULL networks:</u> Malmö living lab, MEDEA
BICYCLE LIBRARY	Western Harbour (Malmö)	City	<u>Urban planning & facilitating sustainable lifestyles</u> An initiative offering the possibility of lending unconventional types bikes (e.g. electric, cargo) for people to test and see if they could use the bike type to move around the city, before buying one of their own.	<u>Environmental:</u> sustainable transportation, sustainable lifestyles.	2015-2016 (or 2018, to be decided)	Enabler-driven	Bicycle Kitchen	<u>Public:</u> Swedish Transportation Administrator <u>Non-profit organisation:</u> Bicycle Kitchen, STPLN <u>Researchers:</u> IIIIEE at Lund University
HÅLLBARHETEN	Western Harbour (Malmö)	Building	<u>Research environment</u> Apartment building where new technologies are tested by the residents.	<u>Environmental:</u> energy efficiency, sustainable housing, energy delivery	April 2013 – March 2016	Utiliser-driven	E.ON	<u>Public:</u> (City of Malmö) <u>Private:</u> E.ON, InUse, Hauschild-Siegel <u>Researchers:</u> Birmingham University, unnamed Italian university.
ELIS	Malmö	Four buildings	<u>Research environment</u> Developed mobile application to monitor and lower energy use in existing housing (not new developments).	<u>Environmental:</u> energy efficiency	2012-2014	Provider-driven	Malmö University	<u>Public:</u> City of Malmö <u>Private:</u> E.ON, Ericsson, IBM, MKB, Media Evolution, Mobile Heights, Schneider Electric, Sony Mobile, <u>Researchers:</u> Malmö University, Blekinge Institute of Technology, Luleå University of Technology, Malmö University
MALMÖ INNOVATION PLATTFORM	Malmö	City district/ parts of city	<u>Urban planning</u> Innovation platform supporting the retrofitting of existing apartment buildings.	<u>Social:</u> socio-economic development, business opportunities <u>Environmental:</u> e.g. energy efficiency	2013-2015	Enabler-driven	City of Malmö, Environmental Department	<u>Public:</u> City of Malmö - Environmental Department, Region Skåne <u>Private:</u> Media Evolution, E.ON, MKB (plus at least 13 other partners) <u>Researchers:</u> Lund University, Malmö University, the Swedish University for Agricultural Sciences in Alnarp
UBIGO	Gothenburg	City	<u>Research environment</u> Tested mobile service to ease and facilitate city transportation.	<u>Environmental:</u> sustainable transportation	November 2013 - April 2014	Provider-driven	Lindholmen Science Park	<u>Public:</u> Swedish Transport Administration, City of Gothenburg, Region Västra Götaland <u>Private:</u> Västtrafik, AB Volvo, Tyréns, Arby Communications, PayEx Finance, Move About, etc. <u>Researchers:</u> Lindholmen Science Park, Chalmers University of Technology, Mistra Urban Futures, Viktoria - Swedish ICT
HSB LIVING LAB	Gothenburg	Building	<u>Research environment</u> Planned student housing acting as a test bed for various building technologies and collaborative processes.	<u>Social:</u> the democratic process in housing cooperatives <u>Environmental:</u> energy efficiency, sustainable housing	2016-2026	Utiliser-driven	HSB	<u>Private:</u> HSB, Akademiska Hus, Chalmers Studentbostäder, Tengblom, Bengt Dahlgren, Peab, Electrolux, Göteborg energi, Vedum <u>Researchers:</u> Johanneberg Science Park, Chalmers University of Technology <u>Network organisation:</u> Climate-KIC

URBAN LIVING LAB	LOCATION	SCALE	DESCRIPTION	SUSTAINABILITY FOCUS	DURATION	DRIVER	COORDINATOR	KEY ACTORS
SHAPE YOUR WORLD	Botkyrka (Stockholm)	City district	<u>Urban planning & co-creation</u> Youth focused urban gardening to create sustainability and learn about ULL-methodology.	<u>Social:</u> social uplifting <u>Environmental:</u> urban gardening, education on sustainability	2013-2014	Enabler/ provider-driven	IVL Swedish Environmental Research Centre, Botkyrka municipality	<u>Public:</u> Botkyrka municipality, Alby youth Club <u>Private:</u> Boodla <u>Researchers:</u> IVL Swedish Environmental Research Centre <u>ULL networks:</u> SubUrbanLab, JPI Urban Europe
NEW LIGHT ON ALBY HILL	Botkyrka (Stockholm)	City district	<u>Urban planning & co-creation</u> Instalment of LED-lighting to improve attractiveness and security of public spaces and learn about ULL-methodology.	<u>Social:</u> social uplifting, security <u>Environmental:</u> energy efficiency	2014-2015	Enabler/ provider-driven	IVL Swedish Environmental Research Centre, Botkyrka municipality	<u>Public:</u> Botkyrka municipality <u>Private:</u> Mitt Alby AB, <u>Researchers:</u> IVL Swedish Environmental Research Centre , Konstfack University College of Arts <u>ULL networks:</u> SubUrbanLab, JPI Urban Europe
VACANT SPACE ALBY	Botkyrka (Stockholm)	City district	<u>Urban planning & co-creation</u> Inclusive urban planning process to make use of a vacant space.	<u>Social:</u> democracy, citizen involvement in urban planning	2014-2015	Enabler/ provider-driven	IVL Swedish Environmental Research Centre, Botkyrka municipality	<u>Public:</u> Botkyrka municipality <u>Researchers:</u> IVL Swedish Environmental Research Centre <u>ULL networks:</u> SubUrbanLab, JPI Urban Europe <u>Other:</u> Alby District Group (a network of representatives from the municipality, local organisations and private actors).
FÄRGFABRIKEN	Stockholm	City (international reach)	<u>Urban planning</u> Urban planning processes is discussed and debated to generate a vision of the future city of Stockholm (and other European cities).	<u>Social:</u> democracy, citizen involvement in urban planning <u>Environmental:</u> environmental aspects are considered in the discussions	2010- undetermined	Enabler-driven	Färgfabriken	<u>Public:</u> Swedish Transportation Administration, County Administrative Board Stockholm, City of Stockholm, Nacka municipality, Södertälje municipality, Värmdö municipality, Swedish Institute. <u>Private:</u> Stockholm Public Transport, Veidekke, Prints of Stockholm, Swedish Chamber of Commerce, etc. <u>Researchers:</u> KTH Royal Institute of Technology, Stockholm Environmental Institute, The Bartlett School of Architecture, <u>Non-profit organisation:</u> Swedish Society for Nature Conservation Stockholm, Goethe Institute <u>ULL networks:</u> JPI Urban Europe (CASUAL-project)
HS2020	Hammarby Sjöstad (Stockholm)	City district	<u>Research environment & urban planning</u> City district seeking to act as an innovation platform for sustainable development of cities.	<u>Environmental:</u> sustainable transportation, sustainable housing, energy efficiency, water quality, recycling etc.	2011 – undetermined	User-driven	Hammarby Sjöstad Association	<u>Public:</u> Swedish Environmental Department, Traffic department. <u>Private:</u> Volvo car, Volvo busses, Riksbyggen, Dalkia, Envac. <u>Researchers:</u> KTH Royal Institute of Technology, IVL Swedish Environmental Research Centre
ECOTELL (TEEA-LL)	-	IT-platform	<u>Research environment</u> Develops IT- and logistics solutions for transportation, and test them in a virtual lab environment.	<u>Environmental:</u> efficient transportation	2014-2016	Provider-driven	IVL Swedish Environmental Research Centre	<u>Private:</u> Axelerate Motorsport, Bring, DSV Road, Fraktkedjan Väst, Posttrack Europe, Preem, Scania CV, Volvo Technology, ÖGS bolaget, <u>Researchers:</u> IVL Swedish Environmental Research Centre , SICS – Swedish ICT, Chalmers University of Technology <u>Non-profit association:</u> Network for Transportation Measures <u>ULL-networks:</u> ENoLL

4.2 Case Studies

This section presents the findings from the four in-depth case studies: UbiGo, Hållbarheten, Shape Your World, and Fabriken. Background, goals and visions, operations, and evaluations of the selected ULLs are presented. Table 5 gives an initial overview of the cases' characteristics followed by four sub-sections presenting the findings of each case study in more detail.

Table 5 Overview of the ULL case studies

	UBIGO	HÅLLBARHETEN	SHAPE YOUR WORLD	FABRIKEN
GOAL & VISION	<p>Reduce the need for a private car ownership.</p> <p>Reduce emissions from transportation.</p> <p>Develop and test a business solution promoting sustainable travel in cities.</p> <p>Making cities greener, safer and more attractive.</p>	<p>Develop new products and services for a sustainable housing.</p> <p>Identify business opportunities.</p>	<p>Increase the knowledge of ULL methodology.</p> <p>Increase social and environmental sustainability in less valued suburbs.</p>	<p>Function as a meeting place inspiring co-creation and innovation.</p> <p>Providing access to tools and equipment for users to create things on their own.</p>
DRIVER	Provider-driven	Utiliser-driven	Enabler/provider-driven	User-driven
COORDINATOR	Lindholmen Science Park	E.ON	IVL Swedish Environmental Research Centre	STPLN
PARTNERS	<p><u>Public:</u> Swedish Transport Administration, City of Gothenburg, Region Västra Götaland</p> <p><u>Private:</u> Västtrafik, AB Volvo, Tyréns, Arby Communications, PayEx Finance, Move About. Taxikurir, Hertz, Sunfleet, Styr&Ställ</p> <p><u>Researchers:</u> Chalmers University of Technology, Mistra Urban Futures, Viktoria - Swedish ICT</p>	<p><u>Private:</u> InUse, Hauschild-Siegel</p> <p><u>Researchers:</u> Birmingham University, unnamed Italian university</p>	<p><u>Public:</u> Botkyrka municipality, Alby Youth Club</p> <p><u>Private:</u> Boodla</p>	<p><u>Public:</u> City of Malmö</p> <p><u>Private:</u> Arduino verkstad</p> <p><u>Researcher:</u> Malmö University</p> <p><u>NGOs:</u> STPLN, Bicycle Kitchen</p>
EVALUATED ASPECTS	Carbon emissions saved, NOx-emissions saved, behaviour changes, travel service, outreach.	Products and services tested, energy use, sustainable transportation.	ULL methodology, saved carbon emissions, participatory processers, learning gained by users.	Number of users, demographic of users, outreach, processes of establishing and operating the lab.

4.2.1 UbiGo

UbiGo is a living lab run during the period of November 2013 - April 2014 as a part of the mobility project Go:Smart. The overarching goal of Go:Smart was to develop and test an application that would ease everyday life for people living in cities and to create better conditions for sustainable travel (Vinnova 2014). Another guidance for the project was also a vision of “future urban households choosing access to mobility over car ownership as customers to a reliable, flexible, and rewarding global service, thus making cities around the world greener, safer, and more attractive” (Lindholmen Science Park 2014).

The service developed within the project was tested in the living lab UbiGo. UbiGo is a mobile phone application that provides access to alternative means of transportation to private car use. Public transportation, car-pools, bike-pools, car sharing and taxis could all be paid for and booked through the application (Lindholmen Science Park 2013). In order to promote the use of the transportation means included in the service, the sustainable travel choices were rewarded: for every kg of CO₂ saved compared to a private car trip the users received credits, which could be used to buy other services or products like opera tickets or food delivery (Vinnova 2014; Kuschel, M. 2015, pers. comm., 2 April).

The service was tested by 71 households in Gothenburg (Vinnova 2014). The users had a monthly subscription to the combination of transportation means they desired and paid for the service (Vinnova 2014), thereby simulating a scenario in which the service was offered as a real, permanent service for the users (Moen, I. 2015, pers. comm., 25 March).

A variety of actors were involved in the development and operation of the lab - public bodies, businesses of different sizes, and academia (see table 5). The actors all had their own motivations for participating in the project and came together since they shared the common vision of sustainable travel (Karlsson, M. 2015, pers. comm., 21 April; Kuschel, M. 2015, pers. comm., 2 April). The City of Gothenburg participated since the solution could serve as a means to achieve city sustainability goals, while researchers were more interested in behaviour change and travel habits, and others were driven by either the IT or business aspects (Kuschel, M. 2015, pers. comm., 2 April).

The evaluations of UbiGo focused on the users' attitudes towards the service and the use of different transportations means before and after participation in the lab, the environmental gain from the service, and the business solution itself (Karlsson, M. 2015, pers. comm., 21 April). During the test period the users gave feedback and the application was changed accordingly, if it was possible (Vinnova 2014). To evaluate and record results the participating households took part in the interviews, focus groups and held travel diaries during the testing phase (Sochor et.al 2014).

The results of the lab were positive: 79% of the participating households said they definitely would be interested in becoming customers if the service was offered again (Sochor et.al 2014a); 43% changed their choice of transportation due to the application; and 34% reported that they had changed their travel planning (Sochor et.al 2014b). Half of the respondent reported that they believed their changed travel habits would last. It

was also concluded that the users had used the means of transportations included in the service (carpooling, trams, bus, rental cars and taxis) more than previously (Sochor et.al 2015).

The environmental gain of the lab was estimated by analysing the use of different transportation means through the service. It is estimated that ca. 45 000 kg CO₂ has been saved during the lab's operations due to the increased use of sustainable transportation means (Kuschel, M. 2015, pers. comm., 2 April).

4.2.2 Hållbarheten

Hållbarheten is an apartment building located in the newly developed city district of Western Harbour in Malmö. Western Harbour was an old industrial area that in recent years has been developed into a residential and office neighbourhood with the vision of achieving a high level of sustainability in terms of city planning, energy and water use, waste solutions and green areas (City of Malmö 2015b). The building was set up by the energy company E.ON to develop and test new energy solutions for residential buildings (E.ON 2015a). The goal of the three years long lab is to generate knowledge on which solutions are suitable for the "future sustainable home" and to develop and study products and services that can realise that vision (Rosen, P. 2015 pers. comm., 7 April). E.ON also seeks to identify future business opportunities through the feedback gained from the residents (Rosen, P. 2015, pers. comm., 7 April).

On April 1st 2013 seven families moved into the apartments in the building (Fig. 4). The apartments differ in energy sources and energy delivery systems with a mix of solar power, wind power, solar heating, biogas and district heating (E.ON 2013). Included in the rent, each family is given some means of transportation. All families have their own electric bike, five have an electric car, and those without a car instead have the possibility of leasing a biogas driven car (E.ON 2013). The building itself is designed to encourage a sustainable lifestyle. Storage space is limited in order to discourage consumption, and lots of greenery and a swimming pool in the courtyard encourages stay-at-home vacations, in order to lower emissions from travel (Rosen, P. 2015, pers. comm., 7 April).



Figure 4 Hållbarheten exterior

Picture source: Hållbarheten i Västra Hamnen, by E.ON, licensed by CC 3.0.

The residents can monitor and control the energy use through an app (Fig. 5). The app shows visual representation of the energy used in each room of the apartment, energy used by the electric car and the energy produced by the energy sources of the building (E.ON 2015b). Over 100 measurement points are spread over each apartment, giving a detailed feedback about energy use and temperature (E.ON 2015b). Additionally, the residents can view a prediction of the energy cost per hour for the coming 24 hours. The visual presentation and easy access to cost predictions is hoped to increase the residents' awareness and encourage them to lower their energy use (Inuse 2015). The app can be used when away from home, for instance, to start a washing cycle when the energy costs are low, or lower temperatures while nobody is home (Inuse 2015).



Figure 5 App used by residents of Hållbarheten to monitor energy use

Picture source: Energin styrs via app, by E.ON, licensed by CC 3.0.

E.ON has several partners collaborating within Hållbarheten project. The building was designed by an architect firm, the app was developed by a software consultancy, and the Universities of Birmingham and Italy contributed by evaluating some of the energy solutions (Rosen, P. 2015, pers. comm., 7 April). Although not a direct partner, the city of Malmö has affected the project to some extent by imposing energy requirements, green factor requirements and limiting the number of parking spaces available (Rosen, P. 2015, pers. comm., 7 April).

Per Rosen, who is responsible for monitoring and evaluation of Hållbarheten at E.ON, explains how the results of the lab are evaluated (2015, pers. comm., 7 April). Evaluation focuses on the energy systems installed, the app, the design of the building, and the transportation solutions. The solar power was evaluated by a PhD dissertation done at an Italian University, and batteries were evaluated by the University of Birmingham. E.ON monitors and evaluates all aspects of the project through the user feedback via surveys and direct contact with the residents. The lab is planned to continue until April 30th 2016, when a concluding analysis of Hållbarheten will be performed and is expected to give a more complete view of the lab's results. How Hållbarheten will be used after the completion of the test period is to be decided (Rosen, P. 2015, pers. comm., 7 April).

4.2.3 Shape Your World

The lab Shape Your World is a part of the SubUrbanLab project, a cooperative effort between Sweden and Finland that aims to create well-functioning and sustainable cities as well as develop and enhance the knowledge of the ULL-methodology (SubUrbanLab 2015b). More specifically, each country runs three living labs in suburbs to modernise and socially uplift communities in less attractive areas (SubUrbanLab 2015b). In the beginning of the project a review of ULL-methodology was done and a guide for designing and managing ULLs was created. The conclusion from the guide is that the involvement of users and other stakeholders is central to the ULL-methodology, and that co-creation plays a significant role in all six labs (Karlsson, A. 2015, pers. comm., 25 March, Friedrich et al. 2013).

The three Swedish labs are located in Botkyrka, a suburb of Stockholm, and focus on environmental and social sustainability. The labs are coordinated by IVL Swedish Environmental Research Centre in a close collaboration with the municipality of Botkyrka, which has been involved throughout the process (Isgren, G. 2015, pers. comm., 31 March; Karlsson, A. 2015, pers. comm., 25 March). The lab activities are therefore closely linked to long term goals for the development of the area, which were set by the municipality (Isgren, G. 2015, pers. comm., 31 March).

Shape Your World (Fig. 6) is an urban gardening initiative focusing on the social inclusion of youths between 12 and 14 years old (Karlsson, A. 2015, pers. comm., 25 March). Through the lab youths are given an opportunity to increase their knowledge and understanding of sustainable development while actively contributing to the uplifting and attractiveness of the areas (SubUrbanLab 2015c). The lab worked closely not only with the municipality, but also an initiative named Boodla which uses urban gardening to strengthen the community feeling, participation and safety of residents, and the Alby Youth Club - a meeting place for youth in the area (Karlsson, A. 2015, pers. comm., 25 March; Boodla 2015).



Figure 6 Urban gardening project Shape Your World

Picture source: Anja Karlsson.

The gardening took place during spring to autumn 2014 and has since been evaluated on many levels by IVL Swedish Environmental Research Centre. The evaluation centred on the level of participation and efforts to engage youths to join, how much participants learned, and the environmental effect of the lab as gauged by estimated carbon uptake (Karlsson, A. 2015, pers. comm., 25 March). As the SubUrbanLab project nears its completion, all six labs will be reviewed to develop the ULL methodology and further the understanding of ULLs' effect on and contribution to sustainable urban development (SubUrbanLab 2015b).

4.2.4 Fabriken

Stapeln (STPLN) is a makerspace in Malmö that hosts a combination of different activities with Fabriken being one of them. The process of creating STPLN was initiated by the city of Malmö in 2006 (Lundholm, C. 2015, pers. comm., 2 March). The initial purpose was to create a meeting place for older youths, (later changing to include people of all ages) out of an old building previously used in the shipbuilding industry in Western Harbour¹¹ (Lundholm, C. 2015, pers. comm., 2 March). Despite being initiated by the City of Malmö (a provider) STPLN was given free reins, and their activities, including Fabriken, were developed solely by the users without any provider involvement. Since the beginning a pillar in the development of STPLN was to include the perspective of the users of the space; the building was to be used in the way the users wanted - a bottom-up approach (Lundholm, C. 2015, pers. comm., 2 March). After renovating the building and developing the concept with the users, STPLN was established as a non-profit organisation, and now hosts a diverse range of activities such as the public makerspace (Fabriken), an open office, a stage, a workshop allowing youth to discover digital technologies (Kreatech) and singular events such as conferences and meetings (STPLN 2015).

Fabriken was launched on April 1st 2011 as a living lab with the purpose of giving people the opportunity to build, design, and develop things that are not available in stores (STPLN 2015). 3D-printers, hand tools, laser cutters, and equipment to work with electronics is now available in the lab (Fig. 7, Fig. 8) which gives the users the opportunity to experiment, share and co-create ideas. Fabriken also hosts other initiatives like a bike repair workshop (now run as a separate organisation), a space where leftover industry material can be used to create new objects, a textile workshop, and a screen printing workshop (Seravalli 2014). The lab was developed by STPLN and its users together with the University of Malmö, and has in recent years been managed together with the company Arduino Verkstad, which is in the business of interaction design (Seravalli 2014).

Evaluations of the lab have focused on the demographics and the number of users as well as the outreach done by the STPLN since this is required by the City of Malmö which provides the building (Lundholm, C. 2015, pers. comm., 2 March). Furthermore, the establishment and methodology of the lab have been thoroughly studied and evaluated by the researcher Anna Seravalli from Malmö University who has been involved and following the lab during three years.

¹¹ The same city district in which Hållbarheten is located.



Figure 7 Working station at Fabriken

Picture source: Madeleine Brask



Figure 8 Part of the maker space Fabriken

Picture source: Madeleine Brask

5. Analysis

In this chapter the findings are analysed through the lens of transition management, and the four case studies are contrasted to discover what sustainable transition paths they may contribute to and how the evaluation is performed to give insights into what is learned from the ULLs. Each section seeks to answer one of the three sub-questions of this thesis.

5.1 Goals and Visions

This section seeks to answer sub-question 1: *What are the goals and visions of ULLs and how do they evolve over time?*

As chapter 2 and section 3.1.3 suggests, the visions and goals of a ULL can indicate which transition path the lab seeks to explore. As can be seen in both the mapping of ULL examples and the case studies, the goals and visions of ULLs cover a broad range - from elaborate visions of future sustainable cities with concrete action goals (e.g. UbiGo) to more open ended and explorative visions (e.g. Fabriken).

The overarching vision for Go:Smart which guided the operations of UbiGo was directed at contributing to greener, safer and more attractive cities by targeting the mobility of urban households. Hence, the vision has clear connections to the sustainable development of cities and the lab could be said to explore a transition path of making alternative means of transportation more attractive to households in contrast to private car ownership. Although not expressed in this manner by the partners themselves, the project goal was to develop a service facilitating this transition path. Both the vision and the goals were developed and agreed upon by the partners early in the process, even though the partners had their own motivations for participating in the project. A parallel can be seen with the tactical phase of the TM cycle, where goals and transition paths are derived and stakeholders come together and form common visions and experiments to undertake in the operational phase of transitions, despite having separate interests and operating in different domains of society (Loorbach 2010).

The vision and goals of Hållbarheten are focused on business development and gaining knowledge from the lab's users for product and service development. According to Leminen et al. (2012) this is characteristic of a utiliser-driven lab like Hållbarheten. A

key difference between UbiGo and Hållbarheten is the number of actors involved in the vision-making. A large number of actors were involved in UbiGo, whereas E.ON itself is the main stakeholder and by itself leads the development of vision and goals for Hållbarheten.

The goal of Shape Your World is closely related to the overall goal and mission for the SubUrbanLab project, initiated by the funding body JPI Urban Europe, which states that the mission is to explore ULL methodology and to spread lessons learned throughout Europe (SubUrbanLab 2015b). Shape Your World functions as a test environment for the ULL methodology and has, like all labs set up within the project, a separate goal of its own – to deploy an urban gardening project for youths in a less valued suburb. That goal was developed as result of a close collaboration between the IVL and the municipality of Botkyrka, and is linked to regional and local development goals and the research performed within SubUrbanLab project.

Fabriken stands out due to its goals being rather open ended. It was developed as a result of its host organisation's (STPLN) vision: to function as a meeting place that reflects the users' activities and interests. This vision originated from the city of Malmö and developed further over the initial years of operation (Lundholm, C. 2015, pers. comm., 2 March). Fabriken represents one effort to realise this vision and has its own vision of making expensive equipment and tools accessible for all groups of society.

Similar to the four case studies the other ULLs mapped include labs with a range of different focuses, goals, and visions. Some focus rather on environmental sustainability, others on the social aspect of sustainable development, while others reflect a bigger picture including many aspects of sustainability. Energy efficiency (Elis), sustainable transportation (Eco-tell, Bike Library), sustainable development of cities as a whole (Färgfabriken, HS2020, Malmö Innovation Platform), and sustainable housing (HSB living lab), are some of the areas represented by the labs mapped and the labs have the potential to explore transition paths within these domains.

It is not uncommon for the visions and goals of transitions to change over time (Rotmans et al. 2001). It is considered a natural part of the transition since the transition process is a collective learning approach (Rotmans et al. 2001). Likewise, the goals and visions of ULLs change, often as a consequence of the real world setting of the labs forcing the projects to adjust to its altering circumstances. Anja Karlsson, a project leader of the Shape Your World ULL, expresses it as follows:

"We had to adapt to reality (...) a ULL has to react and respond to the context and existing structures." (Karlsson, A. 2015, pers. comm., 25 March)

The goals of Shape Your World changed during the time the lab was active. Karlsson, A. (pers. comm., 25 March), says the targeted age group changed from 12-18 years old to 12-14 years old due to this group being easier to reach, and the location of the urban gardening was also changed. However, the main goal to examine the ULL methodology has remained the same (Karlsson, A. 2015, pers. comm., 25 March).

The visions of both Hållbarheten and Fabriken have also changed. E.ON originally had an ambitious vision for Hållbarheten, but after the lab turning out to be more complex than expected, with many parallel technical systems installed in the building, the scope of the vision was reduced (Rosen, P. 2015, pers. comm., 7 April). Similarly, the age group and business idea of STPLN, which has directly affected Fabriken ULL, has changed a number of times (Lundholm, C. 2015, pers. comm., 2 March).

UbiGo differs from the rest of the cases by its vision being clear from the start of the project and not changing during the time the lab was active. The practitioners of the lab believe it to be due to the common vision being jointly developed and agreed on early among the actors involved (Karlsson, M. 2015, pers. comm., 21 April; Kuschel, M. 2015, pers. comm., 2 April; Moen, I. 2015, pers. comm., 25 March). In the evaluations of UbiGo it is noted that that the diverse motivation of the actors could have led to problems but with all different actors being represented in the leadership as well as having a shared vision, the collaboration was successful despite the different motivations of the actors (Vinnova 2014).

5.2 Operation and Alignment with Goals and Visions

This section seeks to answer sub-question 2: *How do the operations of the ULLs contribute to the achievement of their goals and visions?*

The diversity in both vision and goals among ULLs allows for a large range of operational activities. Fabriken is meant to function as a meeting place providing access to different types of equipment. The open ended vision of STPLN, which also guides the operation of Fabriken, makes it complex to predict what sustainable transition paths are explored through the lab. However, the operation of Fabriken gives indications of what indirect effects the operational activities of the lab may have on sustainability transitions. It is common for experiments contributing to transitions to start as niche initiatives like Fabriken, and their operations may not be directly derived from the tactical or strategic phase of the TM cycle (Loorbach 2010; Rotmans & Loorbach 2008). Fabriken functions as a meeting place that offers users from a diverse mix of backgrounds access to tools and advanced technologies that otherwise would not be available to them. Bringing together people from different backgrounds can itself foster social sustainability in the form of increased social cohesion and exchange of experience. Additionally, the activities offered may encourage more sustainable lifestyles among the users, due to the upcycling and more efficient use of resources through the activities (Seravalli 2014). That might have a diffuse impact on the regime levels of the society – if the users are inspired to sustainable lifestyles through the lab, their changed normative and cultural values may affect the regimes of societies. Indirect effects on transitions like these are just as important as more direct effects of transition experiments (Loorbach & Rotmans 2010). Fabriken's open-

ended goal and its operations could thereby contribute to a sustainable development in cities, despite that not being an explicitly set goal for the lab– the meeting space may act as an incubator or learning place contributing to societal change, and perhaps both social and environmental urban development.

The urban gardening activity of Shape Your World is not in itself an innovative operation. Instead, the innovative aspect of the lab is the focus on developing an ULL methodology, which builds on the interactive processes and involvement of citizens. Interestingly, this approach is not new to the municipality of Botkyrka. The municipality has applied a similar approach to involve citizens in their projects for at least 10-20 years (Isgren, G. 2015, pers. comm., 31 March). While the municipality might not immensely improve its knowledge of community outreach from the lab, its benefits primarily focus on achieving the vision set for the project, i.e. to develop and spread the ULL methodology through Europe. The municipality benefits from the lab in other ways. The lab contributes to the municipality's long term goals by directly developing green areas and contributing to the social stability in the area, and due to the approach receiving media attention the efforts undertaken by the municipality are communicated to the citizens, which is a part of the municipality's own goals (Isgren, G. 2015, pers. comm., 31 March). With regards to what transition paths the lab might contribute to, the biggest contribution of Shape Your World is arguably the development of ULL methodology, which can later be used in many different ways to create sustainable cities. Besides that, Shape Your World allows youths to learn about sustainability which, like the learning taking place in Fabriken, can come to affect regimes in the long run.

The aspect of time is something that may affect how well a lab fulfils its goals and may contribute to the vision set for the lab. Isgren, G. (2015, pers. comm., 31 March) remarks that it is nearly impossible to understand how Shape Your World will have affected the society due its operational period being too short to study its long term effects.

Hållbarheten's operations are focused on testing technical solutions for sustainable homes (like the app and the different energy delivery systems), but also other solutions that could facilitate sustainable living and lifestyles (like sustainable means of transportation and the design of the building itself). The transition path explored though the operations could thereby be argued to be creating sustainable cities with low emissions by innovation of homes facilitating a low carbon lifestyle for the residents.

In the case of UbiGo the operations clearly relate to the vision and goals for the lab. The actors involved considered the operations of the lab to be successful in achieving the goals set and delivering concrete results (Vinnova 2014; Kuschel, M. 2015, pers. comm., 2 April; Karlsson, M. 2015, pers. comm., 21 April; Moen, I. 2015, pers. comm., 25 March), but despite that the service developed within the lab has not yet become permanently available in the city of Gothenburg after the lab period ended (Kuschel, M. 2015, pers. comm., 2 April).

5.3 Evaluation

This section seeks to answer sub-question 3: *How do ULLs evaluate their activities and achievement of goals?*

All four labs included in the case studies evaluate their activities and fulfilment of goals but to a different extent. Evaluation is a vital part of the reflexive activities of the TM cycle since it allows for learning, which is central for the TM cycle as visions may be adapted based on the knowledge gained (Rotmans et al. 2001). Not every transition path explored has to directly contribute to a transition by delivering concrete results - the purpose of the TM cycle is to learn and work towards the transition needed, meaning that learning gained by exploring an unsuccessful transition path can still be valuable (Rotmans et al. 2001). Similarly, the evaluation is a central element of ULLs and characteristic for the living lab concept (see chapter 2).

In the four case studies, knowledge centres like universities are often involved in the evaluation of the ULLs. Furthermore, funding bodies like Vinnova or JPI Urban Europe influence which aspects of ULLs get evaluated in addition to what is evaluated by the knowledge centres.

For UbiGo a range of aspects has been evaluated including the fulfilment of goals, the feasibility of the business concept, the service itself, CO₂ and NO_x emissions saved during the test period, and the behaviour change of the users (Vinnova 2014, Kuschel, M. 2015, pers. comm., 2 April). The service itself was also evaluated in detail: what kinds of rewards were most popular in the reward system for sustainable travel choices, whether the mobile application was reliable and usable, whether the customer support services were effective, and which payment models were preferred (Vinnova 2014). Furthermore, the effectiveness of outreach (e.g. ensuring that all involved chauffeurs recognised the payment method as valid) and marketing was also evaluated (Vinnova 2014). The funding body Vinnova required evaluation of the Go:Smart project and its results, and Tyréens, a partnering company, evaluated the environmental impact of the service by estimations from the users' choices of transportation (Kuschel, M. 2015, pers. comm. 2 April). Additionally, Chalmers University of Technology was responsible for evaluating the business concept tested, publishing several articles concerning behaviour changes in users after using the service (Vinnova 2014: Sochor et al. 2014a,b; Sochor et al. 2015). An effort was made to gather feedback through a variety of means, and the evaluations yielded clear and tangible results. The evaluations of UbiGo are more extensive than those of Shape Your World and Hållbarheten, which is a clear consequence of the latter two still awaiting their final evaluation.

E.ON performs most of the evaluation of Hållbarheten itself. The technical systems installed in the building are continuously monitored and evaluated, and the residents' experience of living in the apartments is evaluated. Through interviews and surveys the residents give feedback on what they like and dislike about their housing situation (Rosen,

P. 2015, pers. comm., 7 April). Additionally, two universities have evaluated the solar cells installed (Rosen, P. 2015, pers. comm., 7 April). In the case of the Shape Your World ULL, the evaluations were done by the coordinator IVL - covering environmental aspects of the gardening, participation and efforts to involve youths, as well as what the users had learned from the lab. The ULL methodology was also reflected upon, but will be further evaluated at the end of the SubUrbanLab project together with all six labs set up within the project.

Fabriken has been continuously monitored and evaluated while it has been active. Malmö University has been involved in both the evaluation and operation of the lab, contributing with thorough assessments of its approach and results, in particular how the lab has enhanced the awareness of the makers-culture¹² Additionally, STPLN continuously reviews Fabriken's number of users, as well as its demographics.

The evaluations are used for different purposes by the four ULLs. UbiGo evaluated the project to examine the business solution and service that had been developed, and the results from the evaluations are still used to promote and market the service (Kuschel, M. 2015, pers. comm., 2 April). Hållbarheten use their evaluations to discover new business opportunities and to improve the products tested in the lab. SubUrbanLab seeks to use the evaluations of the six individual labs set up in the project to develop ULL methodology and improve the guide that was initially created within the project. The guide is later to be distributed in Europe to spread the ULL methodology. Fabriken evaluates to respond to the requirements of the City of Malmö that grant them to use Fabriken's building, and by Malmö University to contribute to the academic research of the makers culture and related processes.

¹² A contemporary culture emphasising do-it-yourself (DIY) and learning-by-doing in a social environment (Seravalli 2014).

6. Discussion

In section 6.1, 6.2 and 6.3 of this chapter the analysis is reflected upon to answer the overarching research question: *How can ULLs contribute to sustainable transitions in cities?* Implications of the chosen research design are considered together with alternative design choices in section 6.4.

6.1 Reflection on ULLs' Contribution to Sustainability

The goals and visions of ULLs vary broadly. Some have a clear vision of the lab contributing to sustainable development, while others have more open ended goals. Both types have the potential to contribute to sustainability, each in their own way. The four cases studied fell into two groups – the first two had a clear focus on environmental sustainability (UbiGo and Hållbarheten) while the other two (Fabriken and Shape Your World) had a more prevalent focus on social sustainability. Although the latter two do not prioritise environmental sustainability, there is still elements of environmental sustainability incorporated in their operations. Hållbarheten and UbiGo both have a vision of future cities producing less emissions and seek to achieve this by targeting housing and transportation domains respectively. The connection between the solutions developed within the labs and their potential of contributing to sustainable cities is clear - if the solutions were used at a larger scale they could considerably lower emissions and in that way contribute more tangibly to sustainable development. Shape Your World is a small scale lab but if its methodology, which SubUrbanLab project tests through this ULL, turns out to be useful, could be used as a new form of governance towards sustainability. Furthermore, if this methodology is spread throughout Europe the lessons learned from Shape Your World might have a significant impact on urban planning processes in European cities, however that is still to happen. Fabriken's contribution to sustainable urban development, is similar to that of the Shape Your World ULL, rather diffuse when compared to UbiGo and Hållbarheten - in the sense that the users shape the lab to a greater extent as well as its impact reaching a broader spectrum of sectors in society. The lab allows people to meet and learn from each other, and the activities of Fabriken encourage reuse, repurposing, repairing, as well as do-it-yourself (DIY) production which could make users more aware of resource use and inspire more resource efficient sustainable lifestyles. Because of this, Fabriken, despite not having goals clearly linked to

lowering greenhouse gas emissions, the co-creation and learning taking place within the lab may still contribute to a transition towards low carbon cities. Fabriken also functions as a meeting place allowing citizens with different backgrounds to meet which might counteract segregation and improve the social cohesion of the city. Its contribution to social sustainability is thus more direct than its environmental one, but as a whole Fabriken's contribution to sustainability is led by its users and the results is determined by their use of the lab. To summarise, all studied ULLs have a potential to contribute to sustainability transitions either directly or, equally importantly, through indirect means.

All four case studies could be seen as niche initiatives challenging current regimes of society, but the reality may be more complex. There are indications of ULLs being a mix of experimental niche initiatives and existing societal regimes. As Bulkeley and Castán Broto (2013) argue, urban labs are often influenced by current regime trends. For example, SubUrbanLab seeks to develop the ULL methodology as an inclusive urban planning approach, which could be seen as a result of citizen engagement in planning processes being a trend in urban governance (Bulkeley & Castán Broto 2013). Hållbarheten is also an experimental initiative but set up in a newly developed city district of Malmö which seeks to be a sustainable neighbourhood. Hållbarheten is therefore likely to have emerged as a result of the vision for the whole neighbourhood. The impact of regimes affecting Fabriken is more difficult to identify. Users drive the process and use the space as they desire - the bottom-up element is thereby more prominent in Fabriken. However, the possibility of niches being influenced by the regime level does not mean they are less likely to bring about regime shifts. Rather, having linkages with external processes is necessary for niche initiatives since niches themselves cannot bring about regime shifts (Schot & Geels 2008).

The motivation behind the creation of each lab varies. The creation of Fabriken and Hållbarheten are not clearly results of a transition agenda developed in the tactical phase of a transition. While they may be seen as being part of a transition, it is not clear that the intention behind them was to contribute to a transition. In contrast, UbiGo and Shape Your World fit more clearly into the framework of the TM cycle – actors from different domains of society came together and developed the objectives for the labs, seeking to test solutions for achieving a common vision, closely mirroring the model of the tactical phase of a TM cycle. Their visions are also closely linked to a sustainability agenda in a conscious way, whereas Fabriken does not have an overarching vision of sustainability and Hållbarheten is primarily focused on product development with sustainability as a secondary goal.

Related to this is also how the four cases label themselves. Shape Your World is labelled as an ULL by its coordinators and is developed specifically with the ULL-methodology in mind. UbiGo and Fabriken is labelled as living labs. The living lab and ULL concepts are similar since one is developed from the other, and since the focus of the two labs clearly addresses urban issues they still fall under the definition of ULLs. Hållbarheten is not labelled either as a living lab or a ULL but words like experiment and test is used to describe Hållbarheten and its focus on sustainable housing in urban areas

is clear. The fact that the coordinators of the different labs label the labs differently may be reflected in the operation of the labs. Actively naming a lab a ULL may imply benefits when analysed from a transition management viewpoint since the concept of ULLs and transition management are very similar.

The four case studies represent ULL with different drivers – utiliser, provider, enabler and user-driven labs. It is clear that the operation and goals of the labs differ and some of these differences could be due to the driver of the lab. Hållbarheten is, as utiliser-driven labs commonly are, focused on the product development and the numbers of actors involved in the ULL is considerably lower than in the other three labs. A lower number of partners may be a disadvantage in terms of the ULL's potential to contribute to sustainability transitions. For transitions to take place, the changes must take place simultaneously in different domains of society (Rotmans et al. 2001). Hence, if a larger number of actors from different domains of the society participate in a ULL project they might apply the knowledge gained in their own domain, resulting in many different domains working in parallel towards the same transition. However, the actors of ULLs often have different motivations for participating in ULL projects, which could complicate the process of developing and achieving a common vision as they have varied interests. Though, as seen in the case of UbiGo where the actors early on agreed on a shared vision, this is not always true.

6.2 Learning from ULLs

Often the duration of a ULL is limited due to the lab being seen as a project which should be completed in a set amount of time, and thus receiving limited funding. Many of the ULLs mapped in this study are in that way limited by their funding, as was pointed out by ULL representatives during interviews (Isgren, G. 2015, pers. comm., 31 March; Älg, K. 2015, pers. comm., 19 February; Lundholm, C. 2015, pers. comm., 2 March). That might affect the labs' ability to deliver opportunities for learning and in the long run also affect the ULLs possibility to contribute to sustainable development of cities. A ULL active for a short period of time may certainly produce learning, but the evaluations will not have the opportunity to examine long term effects. Societal changes take time. Rotmans et al. (2001) estimated that transition experiments need 5-10 years to grow and become a more mainstream option. Generally, based on the ULLs mapped, the time set for ULLs is shorter than that, meaning that end-of-project evaluations do not include the full effect of a ULL and that they lack time to become mainstream options in the society. ULLs with unlimited and continuous periods of functioning could thereby have a higher potential to contribute to transformative processes in society than the ones that are short-term. According to Leminen et al. (2012) a user-driven lab is generally more long lived than labs with other drivers. Utiliser-driven labs are often short lived while provider- and enabler-driven labs may vary in lifespan, with some being short and others more long term. A user-driven or

other long lived ULL may therefore have a bigger chance of discovering long term effects in its evaluations.

Evaluations have been done of all four labs included as case studies and more evaluations of these ULLs are planned, but what is being evaluated and how it is done differs between the ULLs. Universities or research centres involved in the ULLs often evaluate the labs, resulting in labs being reflected upon on many levels - both on the levels of operations and on long term effects. Funding bodies of ULLs also require some sort of evaluation of the labs they fund. In that sense, funding bodies do to some extent determine what aspects of a lab are evaluated, which means that funding bodies also influence what type of learning is produced from a ULL. To further understand how learning from ULLs is produced the requirements funding bodies set on evaluations could be studied.

The degree of user involvement and users' ability to impact the operation of a ULL can impact the knowledge gained from a lab and thereby also the labs contribution to transitions. If little communication takes place between users and the operating body, and users are merely seen as customers, the knowledge produced is different than if the users themselves drive or co-create the evolution of a lab together with an operational body (Westerlund & Leminen 2011). Judging by the case studies, it is clear that the users' opportunity to impact the operations of the lab differed. In Fabriken the users were very involved and drove the innovation process, while the users of UbiGo and Hållbarheten mainly gave feedback on the solutions tested. Whenever possible user feedback was used to alter the services tested, but due to an app being easier to alter than an apartment building the users of UbiGo had greater influence on lab operations than Hållbarheten's. Investigations of how users are involved in lab activity may therefore be of value for understanding what type of learning ULLs contribute with towards sustainability transitions for cities.

6.3 Spread and Upscaling of ULLs

According to the transition management theory societal structures may be transformed if an experiment deemed successful in terms of its contribution to the transition in question can be repeated in different contexts or scaled up to be a mainstream option (Rotmans & Loorbach 2005). As mentioned above, transitions occur when actors of different societal domains simultaneously work towards the same vision for the future. For this reason the spread or upscaling of a ULL is important for the ULL to contribute to sustainability transitions as it allows the lab to reach into other societal domains. The UbiGo lab is now finalised, and the service tested within the lab has not become a permanently available service in Gothenburg as the involved actors had hoped. However, the key actors are still working to market the service. Shape Your World has plans on spreading the ULL methodology being developed throughout Europe. Through Hållbarheten E.ON seeks to develop products and services to offer their customers so the solutions might spread but

the lab activity will probably not be upscaled. Fabriken was never intended to upscale or spread, but was rather seeking to act on the local level. However, they do host a large number of study visits to the lab each year and the meeting place itself is designed for the users to share their knowledge – so even though upscaling and spread is not an explicit goal for Fabriken, it might facilitate knowledge exchange and spread due to its open design.

Enhancing the knowledge of how the lessons learned through ULLs spread could yield a better understanding of what kind of networks and constellations of actors best facilitate the reproduction and upscaling of ULLs.

6.4 Considerations on Research Design

The mapping of ULLs presented in this thesis is not a complete compilation of all ULLs in Sweden as a consequence of some ULLs being easier to identify than others. ULLs that label themselves as living labs or ULLs are easier to find through searches. Likewise, ULLs connected to living lab networks or research projects focused on living labs can be found in the existing databases. On the other hand, the labs initiated by users through bottom-up initiatives tend to be operating in a less visible manner than the ones started up as top-down initiatives by municipalities, NGOs, companies or alike. Due to that, the ULLs mapped are mainly labs that run through top-down approaches. Only a small number of the labs mapped represents bottom-up initiatives. Despite that, the mapping may provide a basis for a full compilation of the ULLs in Sweden.

The four case studies proved to be useful in gaining a deeper understanding of how different ULLs operate, how they evaluate and revise their activities, and what they aim to achieve. As the mapping has indicated, goals and operations varied greatly among labs, something the four case studies also confirmed. However, the case studies only represent a small portion of the ULLs mapped, and presumably only a minor part of all ULL initiatives in Sweden. Methods such as surveys would have yielded a bigger sample but at the cost of the level of understanding of each case (Bryman 2012). Since the aim of this thesis was not to gather quantitative data but to understand ULLs potential to contribute to sustainability transitions qualitative methods such as case studies are a more suitable approach for investigation. The interviews conducted in this study made it possible to extensively investigate multiple topics as well as ask for clarifications and give follow up questions to enhance understanding, something surveys would not have allowed.

Focus groups with ULL representatives could have been used to further enhance the results obtained. If stakeholders from different ULLs were given the chance to jointly reflect on their use of goals and visions to guide their operations, or learning yielded from their evaluations, the differences and similarities as well as the motivation driving the different ULLs might have been further understood. However, due to limitation on time

and resources in this thesis this was not feasible, but could represent a fruitful avenue for future research.

Lastly, it should be noted that transition management is a theory under development (Loorbach 2010; Loorbach & Rotmans 2010) – consequently, it is not guaranteed that a living lab which according to the model should contribute to sustainable development ends up doing so in reality. However, the theory has previously been applied and deemed useful for investigating living labs (e.g. Schliwa 2013). Additionally, Rotmans et al. (2007), Kemp et al. (2007) and Loorbach (2010) argue that the theory can be useful since it can enhance the understanding of the interaction between different actors and forces in society and the ways in which they govern sustainability transitions.

7. Conclusion

7.1 Main Findings

The thesis examined how ULLs can contribute to the development of sustainable cities by exploring four ULLs located in the three largest cities of Sweden: Stockholm, Gothenburg and Malmö. Transition management theory put the ULLs in a larger context and allowed for an understanding of how goals, visions, operations, and evaluations of ULLs may contribute to the vast societal changes needed for the evolvement of sustainable cities. As the literature on ULLs suggests, the cases differed in their focus and practices. Some ULLs have visions and goals with a clear connection to sustainable development as they seek to explore solutions for e.g. sustainable transportation or housing that facilitates low carbon lifestyles. Others have more open ended visions, allowing the users of the lab to co-create knowledge and achieve learning which in the long run may result in the societal change needed for sustainability transitions to take place. Yet others seek to develop inclusive urban planning methods to be used on a large scale to improve the governance of city development.

Often the actors in ULLs have different motivations for participating in the experimental activities, while a shared vision could bring them together and guide and facilitate their collaboration. Similarly, the operational activities of ULLs may yield different benefits for various actors involved, and the labs can by simultaneously involving many actors contribute to learning in different domains of society which is important for sustainability transitions to occur.

Evaluation is a crucial part of transition management, and constitutes a pillar underlying the ULL concept. ULLs often go through evaluations, but to what extent varies, and so do the aspects under evaluation. Due to the ULLs often having a predetermined or limited lifespan, evaluations are commonly restricted to investigating the short term effects of the lab, thereby potentially missing long term effects.

As a final point, ULLs can fit into the transitions management cycle in different ways, though usually the experimentation taking place fits well into the operational phase, and the evaluation and monitoring can be seen as part of the reflexive phase. The differences occur in the tactical phase, where the goals and operations of some labs are developed by many actors coming together in a way that closely mirrors the theory of transition management, while some other labs emerge independently, without envisioning their role in bringing about big changes in society.

7.2 Future Research

Several questions emerged during the investigation warranting further research. A systematic effort would be needed to identify bottom-up initiated ULLs and include them in the mapping, since these are the ULLs that often operate in a less visible manner. Additionally, the ways in which the degree of user involvement impacts the lab success is another topic of further attention. The requirements put forward by the funding bodies could also be reviewed to understand both how these come to shape the operations themselves, and how they might direct the evaluations and thus affect what is learned from the labs.

Since it seems that some ULLs are best described as being a mix of niche and regime influences, it would be interesting to examine how current regimes influence and shape ULL initiatives. How significant are these influences, and are ULLs mostly niche initiatives challenging current regimes, or are they the forces that transform existing regimes?

Finally, how is the knowledge gained from ULLs spread? What channels play the largest role in communicating new concepts discovered through labs, and which actors and domains of society are reached with existing channels?

Finding answers to these questions will yield deeper insights on the role ULLs can play in fostering urban sustainability transitions.

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Appendix 1: Interview Guide, English version

About the interviewee

What is your role in the project?

How long have you been working on the project?

Background of the lab

Why was the lab set up?

When was the lab established?

Who established the lab?

How is the lab financed?

Aims, activities and actors

What are the aims/objectives of the lab?

What is the problem or issue the lab is trying to address?

Have the aims/objectives changed since the lab was established?

What actions does the lab take?

How do those actions contribute to achieving the aims and addressing the issue the lab was set up to address? (Past, present, future)

What key actors participate and collaborate with the lab or support the lab's goals?

Why these actors in particular?

How did these actors become involved?

Evaluation

How does the lab know if it achieves or makes progress towards its goals?

Does the lab evaluate its actions?

If yes, how is it evaluated?

If yes, who performs the evaluations?

If yes, how are the results of the evaluation used? (i.e. for improving the activities or applying for financing)

Name a few things that worked well for the lab in trying to address the problems it was set up to achieve.

Name a few things that did not work for the lab in trying to address the problems it was set up to achieve.

Has the lessons/experience from the lab been transferred to other countries, regions or cities?

If yes, where and which experiences?

Future

How does the future look for the lab?

Appendix 2: Interview Guide, Swedish version

Om intervjupersonen

Vilken roll har du i verksamheten?

Hur längre har du varit en del av verksamheten?

Bakgrund

Varför startade labbet?

När startade labbet?

Vem var initiativtagare till labbet?

Hur finansieras verksamheten?

Mål, aktiviteter och aktörer

Vad är målet/visionen för verksamheten? Vilket problem ska labbet adressera?

Har målen ändrats under tiden verksamheten varit aktiv?

Vilka aktiviteter består verksamheten av och hur bidrar de till att målen uppnås? (Förr, nu, framtiden?)

Varför dessa verksamheter? Finns någon styrning, eller vad tror du har lett till just den mix av verksamheter som labbet har idag?

Vilka aktörer samarbetar labbet med?

Varför just dessa aktörer?

Hur involverades dessa andra aktörer?

Utvärdering

Hur vet labbet om de uppnår sina mål eller inte?

Utvärderas labbet aktiviteter?

Om ja, hur utvärderas verksamheten?

Om ja, av vem?

Om ja, hur används utvärderingarna? (t.ex. för att förbättra verksamheten, söka finansiering?)

Nämn några framgångsfaktorer/drivkrafter som var viktiga för labbet?

Nämn några utmaningar/felsteg/hinder som ni stötte på i samband med labbet?

Har lärdomarna/erfarenheterna från labbet spridits till andra länder, regioner eller städer?
Om ja, var och vilka lärdomar/erfarenheter?

Framtid

Hur ser framtiden ut för labbet?

Appendix 3: Personal Communication

INTERVIEWEE	POSITION	ULL CONNECTION	INTERVIEW FORM	DATE
Gunilla Isgren	Environmental department, Botkyrka municipality.	Coordinator of the municipality's participation in SubUrbanLab and Shape Your World.	Telephone	March 31 st 2015
Anja Karlsson	Researcher, IVL Swedish Environmental Research Institute.	Project leader of SubUrbanLab and Shape Your World.	Telephone	March 25 th 2015
MariAnne Karlsson	Professor and Head of division of Design & human factors, product and production development, Chalmers.	Responsible for the evaluation of UbiGo and GoSmart.	Telephone	March 21 st 2015
Magnus Kuschel	Managing Director, Commute Greener.	Project manager of <i>The Rewarded Travler</i> , a pre-study for UbiGo. Central in development of UbiGo.	Telephone	April 2 nd 2015
Caroline Lundholm	Head of operations, STPLN.	Managing role at Fabriken.	In person	March 2 nd 2015
Ingemar Moen	Project leader, Lindholmen Science Park.	Project leader of UbiGo and GoSmart.	Telephone	March 26 th 2015
Per Rosén,	Senior Specialist Business Innovation, E.ON Sverige AB.	Responsible for evaluation and monitoring of Hållbarheten.	Telephone	April 7 th 2015
Katarina Älg	Project manager, The Bike Kitchen.	Involved in STPLNs projects (mainly the Bike Kitchen, but also Fabriken).	In person	February 19 th 2015



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