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Classifying Urban Living Labs: innovative approaches to address urban challenges

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Summary

This thesis focuses on Urban Living Labs, a young phenomenon that has gained importance in recent years due to the potential it has shown to solve urban challenges in an innovative way. Because of its novelty, the characteristics and outcomes of Urban Living Labs are difficult to study, both theoretically and empirically. The purpose of this research is to increase the knowledge about Urban Living Lab by exploring the relationship between their characteristics and types (concerning the kind of solutions that they propose to urban challenges). In order to help achieve this purpose, the main research question is divided into five sub-questions, two of them to be answered through theoretical research and three to be covered by empirical analysis:

What is the relationship between the characteristics and the types (concerning the kind of solutions that they propose to urban challenges) of different Urban Living Labs and how can Urban Living Labs be classified based upon those?

The exploratory approach is the best suit for this study, due to the scarcity of academic discussion regarding this subject. The methodology of this research is mainly qualitative; however, it includes the first attempt towards a quantitative analysis, that should be improved in future research. Two types of research design are combined to achieve the research objective. The first one is Systematic Literature Review, to cover the existing academic literature regarding Urban Living Lab. Throughout the Academic Literature Review, it was identified a segmentation in the academic discussion about Urban Living Labs concerning the type of solution that they propose to urban challenges. The three types resulting from this segmentation are technology-driven, transition-driven and citizen-driven. The second type of research design is Case Study, and six projects are analysed to compare how the characteristics are present in different types of Urban Living Labs. The six cases studied in the thesis are The Green Village (NL), Stratumseind 2.0 (NL), ZOHO (NL), Circular Buiksloterham (NL), Living Lab Habitat (BR) and Vrijburcht Community (NL). To study the cases, the methods of research used are interviews with experts and desk research until a saturation point was reached. Each case study resulted in a table compiling a description of characteristics. This table was used to create a definition per type of Urban Living Lab based on the empirical findings.

Comparing the case studies and the theory, the main finding regarding the three types of Urban Living Lab concerns the existence of overlaps between them, meaning that one case can be classified in more than one type. It happens because the characteristics, when applied in real-life, are not mutually exclusive and a case can have features from more than one case. This finding is significant because it shows that reality is more complex than the theory suggests, and it creates a path to be explored in future research regarding hybrid-types of Urban Living Labs and how they can be better implemented in practice to achieve the most that this method has to offer in terms of urban innovation to solve current urban challenges.

Keywords

Urban Experimentation; Urban Living Lab; Technology-driven; Transition-driven; Citizen-driven.

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“O papel é a prisão das palavras. Fora dele, todas são tuas...”

r fiúza

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Abbreviations

AAI	Association Ateliê de Ideias
AMS	Amsterdam Institute for Advanced Metropolitan Solutions
CCLL	Citizen-Centric Living Lab
CPO	Collective Private Commissioning (in Dutch: *Collectief Particulier Opdrachtgeverschap*)
ICT	Information and Communications Technology
IFES	Federal Institute of Espírito Santo (in Portuguese: *Instituto Federal do Espírito Santo*)
IHS	Institute for Housing and Urban Development
ILI	Intelligent Lighting Institute
ECN	Energy research Centre of the Netherlands
ENoLL	European Network of Living Labs
FAPES	Foundation for the Support of Research in Espírito Santo (in Portuguese: *Fundação de Amparo à Pesquisa do Espírito Santo*)
GV	The Green Village
LabTAR	Laboratory of Assistive Technology for Network Collaboration (in Portuguese: *Laboratório de Tecnologias de Apoio a Redes de Colaboração*)
LL	Living Lab
MIT	Massachusetts Institute of Technology
MRDH	Metropolitan Region Rotterdam and The Hague
NWO	Netherlands Organization for Scientific Research
QH	Quadruple Helix
R&D	Research and Development
TU Berlin	Berlin University of Technology (in German: *Technische Universität Berlin*)
TU Delft	Delft University of Technology (in Dutch: *Technische Universiteit Delft*)
TU/e	Eindhoven University of Technology (in Dutch: *Technische Universiteit Eindhoven*)
UCLL	User-Centric Living Labs
UFES	Federal University of Espírito Santo (in Portuguese: *Universidade Federal do Espirito Santo*)
ULL	Urban Living Lab

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Chapter 1: Introduction

1.1 Background

In our urban world there are more people living in the cities than in rural areas. Ongoing challenges to the municipalities are to achieve a sustainable development and to manage the complex urban issues that accompany the growing urban population. It can be especially challenging when the current institutions and organizations are not well equipped to handle uncertainty and complexity whilst they are still addressing societal problems in a top-down and linear fashion. The urban development path based on the optimization of existing structures hinders the introduction of the required changes to achieve long-term sustainability. To deal with new and old urban challenges (such as governance issues, transition to sustainability, climate change resilience and job creation), it is necessary to create new structures to enhance technological, institutional, behavioural, cultural and other breakthroughs (Eriksson, Niitamo, et al., 2005, Loorbach, 2007, Karvonen, Evans, et al., 2013).

Social equality, democracy, sustainability and quality of life must be the new drivers to reach societal innovation (instead of economic growth, efficiency increase and continuing specialization and fragmentation). This requires a re-evaluation of the basic values and standards of our societies, such as our way to collaborate and to develop solutions for environmental and societal issues throughout all levels of actors, from individual to societal. (Loorbach, 2007). Therefore, new forms of collaboration between citizens, public and private bodies are currently being developed in theory and practice, enliven the debate on the co-production topic (Nesti, 2015).

Co-production refers to the active involvement of citizens from the earliest stages of the decision-making process, an involvement that goes beyond consultation (Van Thiel, 2014). When citizens are engaged in the process of co-production of cities, the benefits are user empowerment and provision of services in a more democratic and transparent way. Also, the solutions are better tailored to the user needs resulting in the improvement of the quality of services and in a more efficient use of public resources. Finally, the range of available solutions with public collaboration is wider because users participate suggesting new patterns of service provision (Nesti, 2015), resulting in the aforementioned innovation that a transition towards sustainability demands.

In this context, Living Labs are portrayed as platforms where all the relevant parties for innovation co-creation are brought together (Westerlund and Leminen, 2011) or, according to Nesti (2015, p 5) “as the best innovative co-production tool to face current policy challenges”. The Living Lab concept appeared in the literature for the first time in the 1990s and its creation is often credited to Willian J. Mitchell from the Massachusetts Institute of Technology (MIT), Boston. There was the first Living Lab, which consisted in a real-life setting where people could be monitored in their interactions with innovations regarding the houses of the future. Initially, Living Labs were defined as spaces to test innovation with active involvement of the users (Ballon, Pierson, et al., 2005, Eriksson, Niitamo, et al., 2005, Følstad, 2008, Dutilleul, Birrer, et al., 2010, Schliwa and McCormick, 2016).

The Living Lab approach has gained importance when a new institution emerged in Europe in 2006, the European Network for Living Labs (ENoLL). According to ENoLL (2015), nowadays the network consists of 150 active members inside Europe and abroad. Therefore, it became a very diverse field of knowledge emerging in different areas. One example is iMinds Living Lab, established in 2005 to work towards business and societal innovation related to ICT using an iterative model of stakeholder co-design where the users are included early on and through the innovation process. It conducts tests and experimentation in real-life settings

in Flanders, Brussels and Ghent, in Belgium (ENoLL, 2017b, imec, 2017). The Living Lab Habitat is a case of non-European Urban Living Lab, located in the city of Vitória, Brazil, that is focused on urban development. It resulted from a partnership between the Federal University of Espírito Santo, the NGO Association *Ateliê de Ideias* (AAI) and the community *Território do Bem*, that was initiated in 2006 aiming to produce eco-friendly innovation to improve the living conditions in urban and rural low-income communities (LabTAR, 2016b).

A recent example of an urban-oriented Living Lab project is The Green Village, an initiative of Delft University and the Stichting Green Village, in the city of Delft, The Netherlands, with the support of public and private partners such as the European Regional Development Fund, the Province of South-Holland, the municipality of Delft, Alliander (energy network company), GasTerra (gas trading company), among others. The goal of The Green Village Living Lab is to accelerate the development and implementation of radical innovations required to solve the world's main challenges, in an experimental site (The Green Village, 2017a).

If innovation and creativity are keys to the future (Eriksson, Niitamo, et al., 2005), they must be stimulated also in the way we plan our cities. Although urban experiments have a high risk of failure, when they are successful they result in high rates of return "reframing the emphasis of sustainability from distant targets and government policies to concrete and achievable actions that can be undertaken by a wide variety of urban stakeholders" (Karvonen, Evans, et al., 2013, p 105). The urban living laboratories have been used as platforms for urban innovation and experimentation in cities with goals that vary from small-scale interventions to large-scale social and economic improvement (Juujärvi and Lund, 2016). According to Juujärvi and Lund (2016), Urban Living Labs showed a potential to redefine and tackle the complex urban problems in original ways by enabling bottom-up innovation in a multi-stakeholder approach, where the residents act as users in a real-life environment.

1.2 Problem Statement

Although the definition of the Living Lab concept is still unclear, there are empirical studies on the several key characteristics and principles of Living Labs (Veeckman, Schuurman, et al., 2013b). Even though this topic has been covered by recent academic literature, the relationship between the urban context and the Living Lab approach, with citizens acting as users, is still underexposed (Baccarne, Schuurman, et al., , 2014, Schliwa and McCormick, 2016). At the same time, Living Labs operating in a geographically bounded urban space in the pursuit of sustainability goals are increasingly being conceptualized and defined as Urban Living Labs (Schliwa, 2013, Schliwa and McCormick, 2016), differing from the initial ICT-oriented Living Labs. Hence, the scarce theory and the emerging interest about Urban Living Labs is a call for more precise definitions and systematic research on the concept (Juujärvi and Lund, 2016, Schliwa and McCormick, 2016).

Meanwhile, the application of Urban Living Lab is a very young phenomenon, so its characteristics and outcomes are difficult to study empirically. Furthermore, the diversity of the topic makes it difficult to analyze cases and challenging to effectively categorize them (Schliwa and McCormick, 2016). Based upon literature, there are elements always present in Urban Living Lab projects. However, they still result in quite diverse shapes and forms with a broad range of activities and ambitions to address a great variety of urban sustainability challenges, such as urban planning; social development; economic growth; environmental sustainability and resilience; and consumption, behaviour and lifestyles. Furthermore, there was a shift from the traditional approach of Living Labs from user-driven ICT systems development towards smart city technologies (Voytenko, McCormick, et al., 2016).

The diversity of focuses of Urban Living Labs makes cities and citizens wonder what exactly this approach is and how it can be set up (Steen and Van Bueren, 2017). For instance, while some initiatives prefer to implement technological solutions when dealing with urban issues, other projects when facing similar urban challenges may opt for changes in the way the actor cooperates, which exemplifies a difference in the kind of solution they propose to the same urban issue. The absence of studies relating these types of solutions to their characteristics, such as timespan, scale, etc., makes it harder to classify them and to understand their particularities regarding goals, activities, participants and context.

A further challenge to study the phenomenon is the existence of many different initiatives under the Urban Living Lab umbrella being studied together, and initiatives that fit the broad definition of Urban Living Labs that are not labelled as such. Moreover, it is not known which models of ULLs projects are more suitable for achieving certain kinds of urban development outcomes for the city or the community where it is located. For instance, although both are labelled as Urban Living Labs, Living Lab Habitat and The Green Village have different approaches related to the role of the public sector and have different urban innovations resulting from their activities.

To conclude, it was noticed that none of the efforts to categorize the Urban Living Labs so far linked their key characteristics to the type of solutions that they propose to urban challenges.

1.3 Research Objective

The research aims to classify various types of Urban Living Labs by exploring the relationship between their characteristics and the kind of solutions that they propose to urban challenges.

1.4 Research Question

Main Research Question:

What is the relationship between the characteristics and the types (concerning the kind of solutions that they propose to urban challenges) of different Urban Living Labs and how can Urban Living Labs be classified based upon those?

Research Sub-questions:

Academic discussion:

1. *What are the main characteristics that define an Urban Living Lab that can be identified in the academic discussion?*
2. *What are the types in terms of solutions for urban challenges of different Urban Living Labs that can be identified in the academic discussion?*

Empirical work:

3. *What main characteristics can be observed in Urban Living Labs in practice?*
4. *How do the various types of Urban Living Labs materialize in practice?*
5. *What patterns can be observed between the main characteristics and the types of Urban Living Labs?*

1.5 Significance of the Study

The aim of an exploratory study is to contribute with information where a reduced amount of knowledge exists, as with Urban Living Labs. Furthermore, it is expected that this research contributes to the upcoming Urban Living Labs implementation by offering new knowledge on the link between the types of solutions adopted when tackling urban issues and the characteristics they must apply in practice to successfully achieve their expected outcomes. In addition, the understanding of the Urban Living Labs performance in the light of their specificities provides a means of identifying possible practical barriers related to the local context and consequently to develop solutions to overcome them. The proposed framework aims to update the existing information about the Urban Living Labs with new empirical data, which has great importance to advance the studies on the subject. Due to the growing importance of the ULLs and their considerable applied implications, the present research is relevant in practice as well. This study is also significant to widen the knowledge about the subject encompassing an existing case outside Europe, since most of the existing academic literature covering the Living Labs subject is being done by European scholars focusing in European cases (Schuurman, De Marez, et al., , 2015).

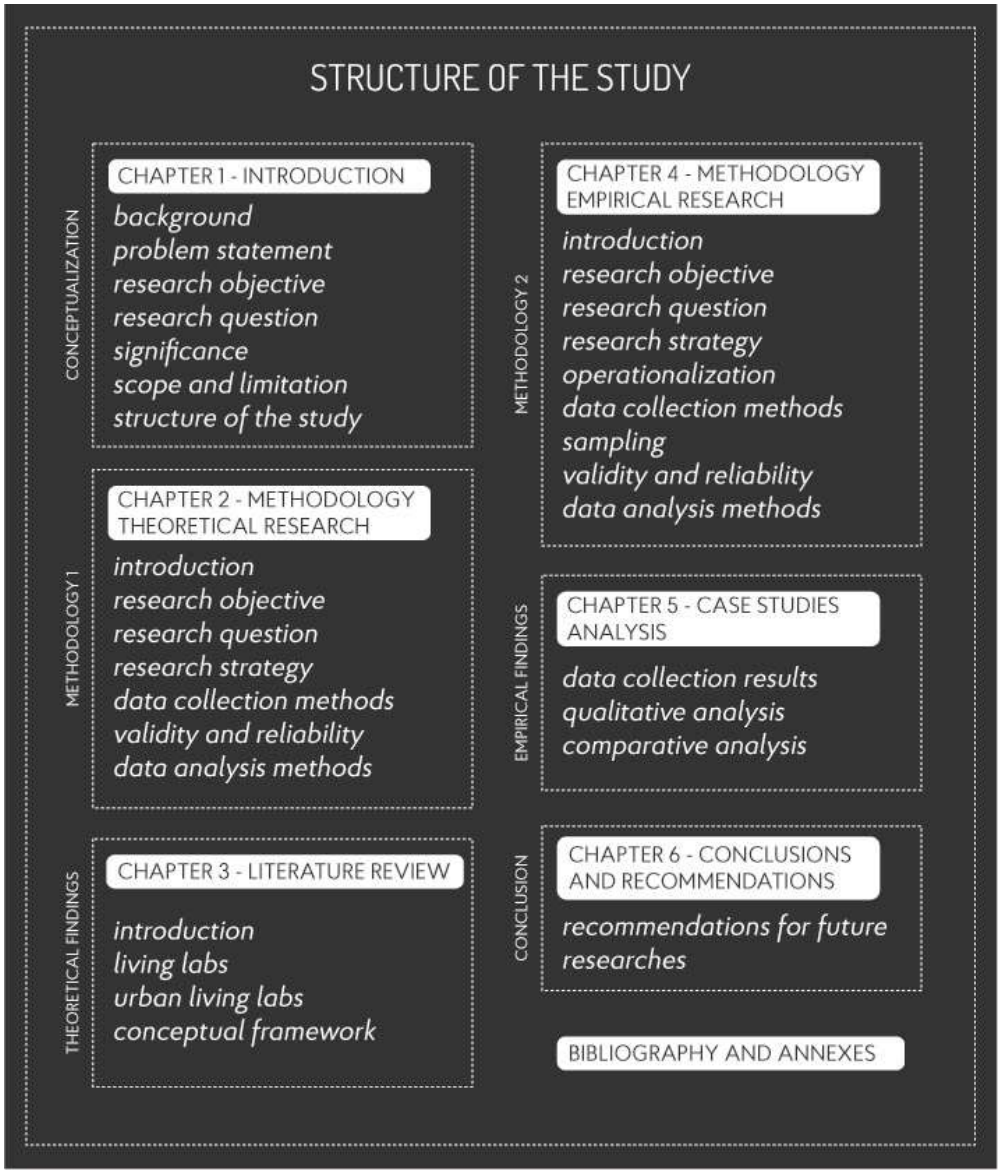
1.6 Scope and Limitations

One of the limitations of the research is the scarcity of theoretical knowledge about Urban Living Labs. Additionally, this subject is challenging to be empirically studied, since it is still a very young phenomenon which makes it harder to extract conclusions analyzing the outcomes generated so far. Considering that the research aims to create categories, it requires a broad study of real cases' features. However, due to the limitation of time and resources available, a reduced selection of cases was studied, which could lead to less external validity (meaning the ability to generalize the study to other situations). Nevertheless, the safest approach to ensure the reliability and validity of this research is to choose multiple heterogeneous case studies, to analyse them aiming to identify patterns and to triangulate the data gathered. Lastly, the language barrier was also a challenge to overcome, first during interviews conducted in ULLs operating in different countries where the spoken language is not the interviewer's mother tongue; and second during the desk research about cases located in The Netherlands and a great amount of data was not available in English. The scope of this study includes ULLs with a perceived approach similar to one of the three identified types, as explained further in the subsequent chapters.

1.7 Structure of the Study

This study has a modular structure (Figure 1) since two different research strategies were chosen. The first one is ***Desk Research*** to get an overview of the existing literature of this rather young phenomenon. A more extensive literature review was elaborated to create a core knowledge required to answer the first two research sub-questions. The methodology for this strategy is presented in Chapter 2 and its findings compose the literature review found in Chapter 3. After that, the theoretical findings were developed into empirical research by comparing multiple cases, in other words, a ***Case Study***. These two strategies combined are essential to answer all the sub-questions and consequently the main research question.

Figure 1: Structure of the study



Source: Author (2017)

Chapter 2: Research Design and Methods 1

2.1 Introduction

This chapter explains the research methodology used to answer the two first research sub-questions, further leading to the answer to the main research question. After recapitulates the research objective and question, already presented in Chapter 1, the research strategy, data collection and analysis methods to conduct the first part of this research are introduced. Two research strategies were chosen, but the one to be addressed by this Chapter is ***Desk Research of Academic Literature***. This strategy was elected to get an overview of the existing literature of this rather young phenomenon and to produce knowledge on the variables of the research question.

2.2 Research Objective and Research Question

Research Objective

The research aims to classify various types of Urban Living Labs by exploring the relationship between their characteristics and the kind of solution that they propose to urban challenges. Although there is theory developed about Living Labs, there is few theoretical information regarding Living Labs dealing with urban issues in the academic discussion. This research aims to deliver an inductive research, that is especially relevant if there is little existing knowledge on a subject and fits in the exploratory feature of the research objective (Van Thiel, 2014).

Main Research Question

The overall research question is:

What is the relationship between the characteristics and the types (concerning the kind of solutions that they propose to urban challenges) of different Urban Living Labs and how can Urban Living Labs be classified based upon those?

Theoretical Research Sub-Questions

The overall question can be answered by combining all the answers to the five sub-questions presented in Chapter 1. The first two sub-questions were addressed by reviewing theory and the current academic discussion. The findings are presented in Chapter 3:

1. *What are the main characteristics that define an Urban Living Lab that can be identified in the academic discussion?*
2. *What are the types in terms of solutions for urban challenges of different Urban Living Labs that can be identified in the academic discussion?*

2.3 Research strategy

The best way to achieve the proposed research objective is to combine theoretical and empirical research approaches. Thus, the theoretical research strategy chosen was ***Desk Research***, particularly a ***Systematic Literature Review***. According to Booth, Sutton, et al. (2012, p 3), the systematic literature review can be used "to identify, select, and appraise all the studies of a previously agreed level of quality (either to include all studies or only those that meet a

minimum quality threshold) that are relevant to a particular question. The results of the studies are then analysed and summarised. Synthesising evidence helps us to find out what we know and don't know about what works and what doesn't work." The systematic literature review was used to first identify and select the relevant studies to Urban Living Lab subject, even though the academic literature about it is scarce. Secondly, the literature review role is to create a conceptualization of this novel subject of study by producing a summary and analysing it, which means that the research will necessarily be exploratory (Van Thiel, 2014). Van Thiel (2014) describes the Desk Research method as the use of existing data sources, namely primary and secondary material. In this research, the strategy drew upon existing secondary data, such as earlier research findings, to create a systematic review. The theory constructed based on this literature review shows how Urban Living Labs have been studied so far and what are their characteristic features and types (concerning the kind of solutions that they propose to urban challenges). To explain these characteristics and types is essential to answer the two theoretical sub-questions. In turn, these answers are essential to produce a coherent conceptual framework and to advance to the empirical phase of this research. Desk Research is also suitable because of its cost-effectivity and efficiency (Van Thiel, 2014).

2.4 Data Collection Methods

The *qualitative* word refers to the nature of the data collected, meaning that the research is based on beliefs and opinions rather than numerical information. This approach is preferred when the research deals with a new phenomenon. Therefore, in this research primary and secondary qualitative data collection and analysis methods were blended in two steps. The first one is secondary qualitative data, described below and summarized in Table 1. The second step is primary qualitative data and it was further described in Chapter 4.

Table 1: Theoretical Research Methodology

Strategy	Data	Method	Approach	Variants	Analysis	Output
Desk research	Secondary	Academic Literature Review	Analysis of the relevant academic literature about Living Labs, Urban Living Labs and other similar subjects, important to construct a coherent conceptual framework.	Thematic ordering and summary	Textual and software (*Mendeley*) supported analysis	Literature review and Conceptual Framework (Ch. 3) Operationalization (Ch. 4)

Source: based on Van Thiel (2014) with modifications by author (2017)

Desk Research – Literature Review

1. Secondary Qualitative Data Collection

a) Academic Literature Review: It consists in the use of existing data, collected, produced and published by other researchers. During the selection process, the author was aware of which variables to concentrate in this current research, i.e. literature that describes the characteristics of Living Labs and Urban Living Labs. Aiming to find relevant literature about the Urban Living Lab phenomenon the following actions were taken:

- Search via academic databases and search engines (Table 2) for articles where the keywords *Living Lab* or *Living Labs* were mentioned on the title. This first search,

conducted in the beginning of September 2017, aimed to discover the size of the academic field about Living Labs

Table 2: Search parameters in the academic databases and search engines

Terms searched	Academic databases/ Search engine	Website link	Results	Search parameters
Living Lab Living Labs	Erasmus University Database	eur.nl/ub/	160 results (in libraries worldwide)	Peer-reviewed articles in English
	ResearchGate	researchgate.net	100+ results	Articles
	ScienceDirect	sciencedirect.com	100 results	Articles in journals and books
	Scielo	scielo.org	4 results	Articles
	Google Scholar	scholar.google.com	1310 results	Articles, excluding patents and citations.

Source: Author (2017)

- Considering that the search results had many publications in common, a previous systematic literature review conducted by Schuurman, De Marez, et al. (2015) presenting an analysis of 45 articles was used to compare the articles selected by the authors with the ones found in the search in the academic databases: 13 of these articles were selected, focusing on published articles approaching the Living Labs subject from a more theoretical perspective, discussing characteristics and definitions. Giving that the authors' literature review covered articles published only between 2005 and 2014, most recent literature was selected from the searches presented in Table 1. Only Google Scholar was used in this step because the search engine covers others relevant academic databases, such as ScienceDirect and TimReview. In the results obtained in a new search in Google Scholar, new articles manually selected by the author, combining three criteria: relevance in number of citation (cited at least 10 times), date of publication (after 2014) and focused on discussed characteristics and definitions of Living Labs;
- Use of snowball approach when selecting new publication from the bibliography of articles which had already been read. This time the selection did not target recent articles (after 2014) and relevance. The new selection aimed published articles discussing features of Living Labs, such as the implementation of Living Labs and the roles performed by the actors;
- This first research into Living Lab subject led to the terms *Open Innovation* and *User Innovation* as its building blocks. The search led to Von Hippel (2005) as most cited author on the *User Innovation* research field and to the author Chesbrough (2006) as the most cited about *Open Innovation*. One publication from each of the authors was appreciated in the systematic review to explain the history of Living Labs and their two main building blocks:
    - *Chesbrough, H. W., 2006. Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press.*

- *Von Hippel, E., 2005. Democratizing innovation: The evolving phenomenon of user innovation. Journal Für Betriebswirtschaft, 55 (1), pp. 63-78.*

- Final selection of 27 publications, including the 13 mentioned before. Because the publications were selected to create a basic knowledge about Living Labs in the academic literature review, publications covering very specific topics, for instance, use of Living Labs in the ICT field, were avoided. This first selection entailed publications discussing Living Labs from a broader perspective, for instance:

  - *Bergvall-Kåreborn, B., Eriksson, C. I., Ståhlbröst, A. and Svensson, J., eds., 2009. A milieu for innovation: defining living labs, [ISPIM Innovation Symposium: 06/12/2009-09/12/2009]*.

  - *Veeckman, C., Schuurman, D., Leminen, S. and Westerlund, M. 2013b. Linking Living Lab characteristics and their outcomes: Towards a conceptual framework. Technology Innovation Management Review, 3 (12).*

- New search in the academic engine Google Scholar was made searching for articles where the keywords *Urban Living Lab* and *Urban Living Labs* were mentioned in the title, resulting in less than 50 occurrences. A new search using the same keywords, however, appearing not only in the title, led to on 445 results (both searches were conducted on *Google Scholar* in the beginning of September 2017). Nine articles were selected from this total, using as criteria of selection their approach to features of Urban Living Labs. Using the snowball method other publications were selected from their reference list using the same criteria;
- Search also for different keywords that were found in the literature about Urban Living Labs such as *Innovation Lab, Urban Laboratory, Social Innovation, Urban Innovation, Urban Experimentation, Sustainable Transition*. Few articles were selected in this step using as criteria the most cited among the results. The inclusion of literature addressing these topics was important to cover publications about similar initiatives that are not being defined and studied as Urban Living Labs. To understand what an Urban Living Lab is not was also an approach presented in Chapter 3 to create the outline of this novel subject;
- In the end, 20 publications about Urban Living Labs and similar approaches were selected, for instance:

  - *Bulkeley, H., Breitfuss, M., Coenen, L., Frantzeskaki, N., et al., 2015. Theoretical Framework: Working Paper on Urban Living Labs and Urban Sustainability Transitions.*

  - *Juujärvi, S. and Pesso, K. 2013. Actor roles in an urban living lab: what can we learn from Suurpelto, Finland? Technology Innovation Management Review, 3 (11), pp. 22-27. Available at: http://timreview.ca/article/742 .*

  - *Loorbach, D., 2007. Transition management: new mode of governance for sustainable development. Erasmus Universiteit Rotterdam.*

  - *Karvonen, A., Evans, J. and van Heur, B. 2013. The Politics of Urban Experiments: radical change or business as usual? In: S. Marvin and M. Hodson eds., 2013. After Sustainable Cities. London, UK: Routledge. pp. 105-114.*

- In the end, about 50 publications such as papers, books, chapter of books and thesis were considered relevant and then systematically reviewed afterward, resulting in the literature review presented in Chapter 3.

2.5 Data Analysis Methods

The secondary qualitative data obtained through literature review was used to better understand the subject and what is already known about Urban Living Labs. The selection done on the relevant existing material, as already explained, was analyzed manually and supported by the software *Mendeley*, in which the literature was added and organized by tags[1]. The chosen literature was studied focusing on:

1) Definition of Living Lab;
2) Definition of Urban Living Lab;
3) Identification of various characteristics of Living Labs;
4) Identification of characteristics of Urban Living Labs;
5) Identification of different types of solutions for urban challenges proposed by Urban Living Labs.

Special attention was given to the other authors' definitions Urban Living Lab. The literature that presented a definition for Urban Living Labs were coded. A code is a label created to divide the data into small units and describe the meaning of a specific part of the data (Van Thiel, 2014). Several codes were created based on the characteristics of Urban Living Labs discovered through the literature review. The definition of Urban Living Lab from several authors was coded, meaning it was divided into small units corresponding to one characteristic from the theory, as presented in the Annex I. Bearing this in mind, the characteristics with more number of occurrences were included in the development of a reframed definition for Urban Living Labs, as explained in the next chapter. In literature review the link between variables (characteristics and types) was further elaborated, resulting in the Conceptual Framework. These variables were operationalized into measurable indicators that were used to study the cases and to formulate the guiding questions for the interviews.

[1] Characteristics, Citizen Empowerment, Co-creation, Governance, Living Lab Definition, Network, Open Innovation, Self-organization, Technology Development, Sustainable Transition, Quadruple Helix, Urban Living Lab Definition, User Innovation, etc.

Chapter 3: Literature Review

3.1 Introduction

The following chapter aims to suggest possible answers to the main question and the two theoretical sub-questions by presenting an overview of the existing debates and arguments about (Urban) Living Labs found in the academic literature. The first part of this literature review discusses a more general Living Labs topic, an approach originally focused on market-oriented innovation. In the second part of this chapter, the Urban Living Lab subject is introduced. Throughout this chapter, several definitions for the concepts *Living Lab* and *Urban Living Lab* are gathered to outline differences and similarities between them. Considering that, the literature review is focused on Urban Living Labs and their relevance in the current debate about co-production and urban experimentation and it was an essential step in the development of the operationalization of ULL's characteristics and the types of solutions for urban challenges they provide.

3.2 Living Labs

3.2.1 What is a Living Lab?

When the term "Living Lab" was used for the first time, the intention was to indicate the *in-situ* nature of different types of research that takes place in a live context. Initially, Living Labs were not seen as an infrastructure but as a delineated part of a real-life environment in which a given study or activity was carried out, without a clear thematic focus (Schuurman, 2015). However, the creation of the Living Lab concept is often credited to Prof William Mitchell, researcher in the Massachusetts Institute of Technology (MIT), Boston, when he proposed to move the research on innovation from *in vitro* to *living spaces* where visitors could be monitored in their interactions with innovations in the context of contemporary computing, sensing and information technology, oriented to the area of smart/future homes. For instance, in 2004, an apartment was equipped to be occupied for several days or weeks and record its inhabitants in their usage of emerging technologies (Eriksson, Niitamo, et al., 2005, Dutilleul, Birrer, et al., 2010, Schliwa and McCormick, 2016).

Moreover, Living Lab was conceptualized by Eriksson et al. (2005, p 4) as "a user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts". Living Labs were also defined as spaces or environments for innovation and development where observations of user experimentation of new ICT solutions in a realistic context are made by designers and researches to test hypotheses (Ballon, Pierson, et al., 2005, Følstad, 2008, Dutilleul, Birrer, et al., 2010).

Besides these definitions, Living Lab as a field of knowledge is very diverse, which results in a lack of common understanding of the concept. Since it is a recent phenomenon that emerged in different areas such as ICT, health care and urban development, there is no clear definition of Living Labs, even though several authors have expressed their definitions, key characteristics and principles or have proposed an harmonization for different methods and tools used by Living Labs (Bergvall-Kåreborn, Eriksson, et al., , 2009, Dutilleul, Birrer, et al., 2010, Veeckman, Schuurman, et al., 2013b, Leminen, 2015).

The literature review regarding Living Labs made by Leminen (2015) came across 70 different definitions of the concept. Some of the definitions found in the existing literature describe Living Lab to this date as: a methodology (Eriksson, Niitamo, et al., 2005, p 5), a system (ENoLL, 2015), a network (van Geenhuizen, 2016), an environment (Ballon, Pierson, et al.,

2005, Følstad, 2008, Westerlund and Leminen, 2011), an organization (Schuurman and Tõnurist, 2017), an arena (Ståhlbröst, 2012) or both an arena and an approach (Schliwa and McCormick, 2016), both a milieu and a methodology (Bergvall-Kåreborn, Eriksson, et al., , 2009) and/or a systemic innovation approach (Feurstein, Hesmer, et al., 2008). Dutilleul et al. (2010) presents five different meanings for which the concept of Living Labs is used: an innovation system, an *in vivo* experimental settings, a space for involving users in innovation, an organisation facilitating living lab approaches, and the European living lab 'movement' (Ballon and Schuurman, 2015). In conclusion, it shows how the concept remain uncertain since its first appearance in the academic discussion.

Nevertheless, Living Labs are still rather insignificant and dominated by Europeans regarding the importance and impact as an academic field (Schuurman, De Marez, et al., , 2015). Whereas in 2008 Følstad (2008) argued that the lack of studies of Living Labs processes and methods are the most pressing challenge for the future of this methodology, five years later Veeckman et al (2013b) affirmed that Living Lab continues an under-researched area in which the absence of a clear definition makes it difficult to advance research about the topic. Contrary to the expectations, the Living Lab approach remains a trend, especially in Europe. In November 2006, an institution named European Network of Living Labs (ENoLL) was founded to stimulate the research about Living Labs. This way the Living Lab approach was put forward as a tool to overcome the gap between research leadership and commercial success of innovation in Europe, in what is known as the "European Paradox" (Veeckman, Schuurman, et al., 2013b). ENoLL (2015, p 12) defines Living Labs as "user-centered, open innovation ecosystems based on a systematic user co-creation approach integrating research and innovation processes in real life communities and settings".

At last, in this research the concept of Living Labs follows the one presented by Schuurman (2015). Box 1 presents a definition of Living Lab derived from the overview of the literature. Four building blocks of this definition were underlined and each of them are discussed in detail in the following section of the Chapter.

Box 1: Definition of Living Lab

Living Labs are an organized approach that aims to achieve open innovation and user innovation through multi-methods of real-life experimentation involving multiple stakeholders.

3.2.2 Characterizing Living Labs

There are several studies assessing Living Labs through different aspects. Based on the definition presented, the aspects to be analysed are: approach (*organized approach*), goal (*achievement of open innovation and user innovation*), activities (*multi-methods*), context (*real-life*) and participants (*multiple stakeholders*). A summary of the main shared characteristics among Living Labs concludes the Section *3.2 Living Labs*.

Organized Approach

Living Lab is defined as an organized approach, as opposed to *ad hoc*[2] approach (Schuurman, 2015). That way, Living Labs can be understood as real-life environments, associated with a

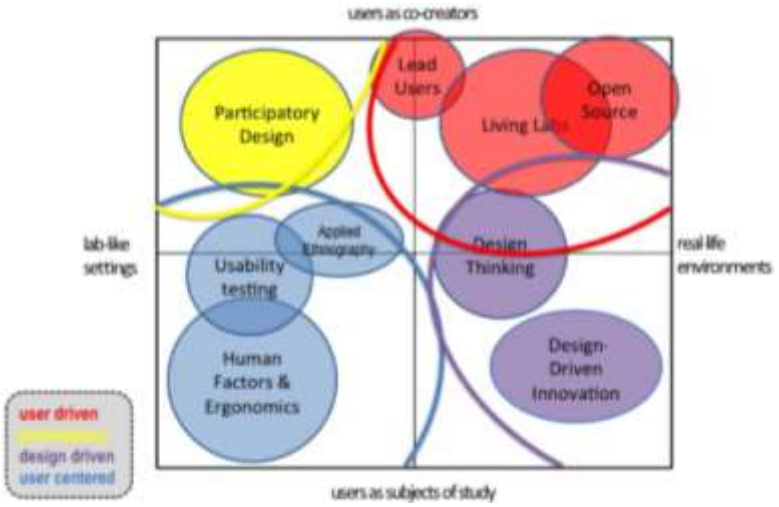
[2] Something that has been formed or used for a specific or immediate purpose, without previous planning.

broad continuum of innovation activities (Leminen, 2015), where *ad hoc* business ecosystems are constructed within their projects (Veeckman, Schuurman, et al., , 2013a). Due to the variety of terms used by other authors to describe this phenomenon and to the diversity of projects considered as Living Labs, even though they have varied methods, organized approach was chosen since most of the definitions previously presented seems to fit in this description.

Goal

The main goal of a Living Lab is to deliver innovation. Although there are other approaches that share this aim with Living Lab, some elements distinguish them. Using two dimensions of interest, Almirall and Lee et al. (2012) positioned the Living Labs in the landscape of other user-innovation methodologies by mapping them in a graph (Figure 2). The first dimension is involvement of users in a co-creative process, varying from users as subject of study (e.g. human factors and ergonomics) in one extreme to users as co-creators in the opposite side (e.g. lead users). The second dimension of interest in the graph speaks to the setting where the project is carried out, whether a lab-like environment (e.g. participatory design) or in the real-life setting in which the users conduct their own activities (e.g. open source) (Almirall, Lee, et al., 2012). The Living Lab approach is in the quadrant of the *users as co-creators* and *real-life environments*, being considered a User Driven methodology, together with Lead Users and Open Source.

Figure 2: Mapping user-innovation methodologies



Source: Almirall, Lee, et al. (2012, p 16)

The major building blocks of the Living Lab concept came from two earlier theories: Open Innovation and User Innovation. Open Innovation was developed by Chesbrough (2006) to explain a new logic behind sources and use of ideas by companies, in which the knowledge came not only from inside them (as in the Closed Innovation approach) but also from outside, i.e. the firms work together with research institutes in R&D. In an Open Innovation mindset, the results are available to be used outside the firms while the innovators are available to hire. This new logic leads to costs savings, increased costumer-value and better performance in innovation delivery and market access (Chesbrough, 2006, van Geenhuizen, 2016). Some differences are identified comparing Living Lab and Open Innovation concepts (Figure 3), although Living Labs are recognized Open Innovation platforms since they are environments

where innovation is co-produced and knowledge is exchanged among participants from different groups, namely private and public sectors, knowledge institutions and users (Ballon, Pierson, et al., 2005, Schuurman, 2015). In the Living Lab approach, external input is present in the whole innovation process, which is focused on the product/service with end-users performing a central role. In contrast, in the Open Innovation method the external input focuses on ideas and technology, with a business model orientation as shown in Figure 3 (Bergvall-Kåreborn, Eriksson, et al., , 2009).

Figure 3: Comparison between Living Lab and Open Innovation

Living Lab	Open Innovation
Business to consumer with a clear focus on user involvement (Ståhlbröst & Bergvall-Kåreborn, 2008; Svensson *et al* ., 2010)	Business to business (Chesbrough, 2006)
Focus on the product/service (Eriksson *et al* ., 2006)	Focus on the business model (Chesbrough & Appleyard, 2007)
External input in the whole innovation process (Svensson & Ihlström Eriksson, 2009a; Ståhlbröst, 2008)	External input focuses on ideas and technology (Smith, 2004)

Source: Bergvall-Kåreborn, Eriksson, et al. (2009, p 2)

According to van Geenhuizen (2016), ideas on user-led innovation and the customer-active paradigm are the major contributions to the development of the Living Labs concept. There are two main approaches on how the aimed innovation led by users can be achieved (Figure 5): the *lead user* and the *crowdsourcing* (Bergvall-Kåreborn, Eriksson, et al., , 2009). Lead User, as defined by von Hippel (2005), means firms or individual consumers are ahead of the innovation process and they are expected to benefit from using a product or a service developed by themselves (Von Hippel, 2005, Bergvall-Kåreborn, Eriksson, et al., , 2009). Defined by Howe in 2008, Crowdsourcing occurs when a company, through an open call, outsources to a large undefined network of people a function once performed by employees and suppliers (Bergvall-Kåreborn, Eriksson, et al., , 2009).

User Innovation is a goal shared by both concepts, however their strategies to achieve an involvement of users and the degree of their participation vary. While Lead User and Crowdsourcing are defined as approaches to innovation, Living Labs are also a milieu, providing the environment where co-creation of innovation is carried out. It should also be noted that the uniqueness of Living Lab compared with the other two approaches remains in the possibility of face-to-face interaction, as opposed to an approach only based on ICT. Another unique feature of Living Labs is their support to the companies offered during the whole innovation process, combined with the work of independent researchers (Figure 4).

Figure 4: Comparison between Living Lab, Lead User and Crowdsourcing concepts

Living Lab	Lead user	Crowdsourcing
Companies outsource the innovation process to the Living Lab, but participate in the process	Company driven innovation process	Company driven innovation process
Both an innovation milieu and an approach to innovation	An approach to innovation	An approach to innovation
Face-to-face and IT-based approach		IT-based approach
Support the whole innovation process	Support parts of or the whole innovation process	Support parts of the innovation process
R&D and independent researchers	R&D	No research

Source: Bergvall-Kåreborn, Eriksson, et al. (2009, p 10)

With that in mind, it seems safe to state that Living Labs have the goal to achieve an Open Innovation and User Innovation status. The following topics discuss how this can be achieved through the activities performed within the Living Lab environment and what are the roles of the participants in this process.

Activities

Regarding the Living Lab methodology, the work of Pierson and Lievens (2005) consists in a detailed attempt at drafting it in a more generally implementable Living Lab methodology, beginning from the User Innovation point of view (Schuurman, 2015). Their five stages methodology is the result of a multiple case study research in which they describe different elements that constitutes a set-up for a Living Lab project (Pierson and Lievens, 2005, Almirall, Lee, et al., 2012, Schuurman, 2015). The first three stages are described as steps to be done pre-measurement of users, enabling the building of a current scenario before the implementation:

> ***Contextualization:*** An exploratory phase aiming to provide the relevant background information and insights around the subject of research. This information is required to define the research framework and to make the selection;
>
> ***Selection:*** this can be done on a socio-demographic level, based on selective or criterion sampling to select eligible users or user groups to participate in the project;
>
> ***Concretization:*** Initial measurement of the current characteristics, behaviour and perceptions of the selected users. This step is vital to enable a post-measurement, after the new technology has been introduced or the innovation has been validated.

The implementation stage applies an intervention in the original scenario previously measured:

> ***Implementation:*** A direct or indirect analysis of the implementation phase is carried out in this step to conduct an actual test and validation. The direct analysis of usage by means of remote data collection techniques, such as logging, and the indirect analysis are based on ethnographic observation and qualitative analysis, like interviews.

The last stage occurs after the implementation and requires a post measurement to compare with the previous results obtained in the first three stages:

> ***Feedback:*** A post-measurement of the users is executed to compare the results with those obtained in the contextualization and implementation phases. The following step is to infer technological recommendations from the analysed data (Pierson and Lievens, 2005, Almirall, Lee, et al., 2012, Schuurman, 2015).

The authors Westerlund and Leminen (2011) highlight four activities performed within Living Lab environments during those methodological stages: co-creation, exploration, experimentation and evaluation. Relating the methodology of Pierson and Lievens (2005) and the activities of Westerlund and Leminen (2011), it can be observed that these two activities are carried out before the implementation:

> ***Co-creation:*** co-creation by users and producers in cooperation with utilizers and enablers;
>
> ***Exploration:*** discovering novel market opportunities, usages and behaviours; capturing from external sources of knowledge to enhance innovation;

The experimentation activity coincides with the implementation period:

> ***Experimentation:*** implementation of live environments within communities of users;

The evaluation is an activity that must be held after the implementation to assess the innovation:

> ***Evaluation:*** assessment of the innovation according criteria, such as socio-ergonomic, socio-cognitive and socio-economic.

While carrying out the described steps, various methods are used to capture, exchange, (re)combine, mix and mould the (tacit) knowledge of all stakeholders (Baccarne, Logghe, et al., 2016).

Participants

Regarding the involvement of the actors in the Living Lab activities, the participants have different motivations to join the innovation development, which requires a reconciliation of their objectives and an equitable division of the returns to co-create value (Westerlund and Leminen, 2011). As Westerlund and Leminen (2011) stated, Living Labs are platforms that bring together the relevant parties (Quadruple Helix model[3]) for innovation co-creation. They are divided by roles as *Utilizers*, *Enablers*, *Producers* and *Users*:

> ***Utilizer:*** Utilizer is a company, enterprise or even a public institution that seeks efficiency gains to develop its business, with a boost in its innovation process through the Living Lab network.
>
> ***Enabler:*** The Enabler could be represented by development organizations (universities, educational institutes and consultants) offering tools, knowledge and methods for research.
>
> ***Provider:*** Providers offer infrastructure, financial support and other necessary resources to the use of participants, aiming promotion of research and theory development, augmenting knowledge creation, and finding solutions to specific problems.
>
> ***Producer and User:*** It is important to emphasize the co-production nature of Living Labs where all actors are producers and they should acknowledge user participation as a key element (Arnkil, Järvensivu, et al., 2010, Westerlund and Leminen, 2011, Juujärvi and Pesso, 2013).

Furthermore, the Living Lab can be differentiated based on which actor manages their activities and plays the most active role in the initial phase or later acts as the principal promoter of innovative activities. The results are four types of Living Labs (*utilizer-driven*, *enabler-driven*, *provider-driven* and *user-driven*) proposed by Leminen, Westerlund, et al. (2012) that differ from each other in terms of activities, structure, organization and coordination (Figure 5).

[3] Quadruple Helix refers to a user-driven model of innovation composed by four helices, where each party is a helix and collaborate with each other to create or discover new technology, knowledge, products and services: academia (colleges/universities), government, industry and users. The inclusion of the user as an actor in the Triple Helix type of innovation (academia + government + industry) means a shift of focus from high-tech innovation based on the latest technology and research knowledge to a production of other kinds of innovations and application of existing technology, research knowledge and user knowledge as well. The companies facing a globalized competition must strive to seek novel sources of competitive advantage such as the more direct involvement of user in various stages of the innovation process (Arnkil, Järvensivu, et al., 2010).

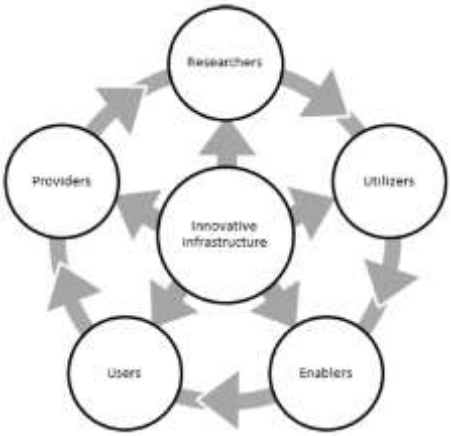
Figure 5: Type of Living Labs

	Utilizer-driven	*Enabler-driven*	*Provider-driven*	*User-driven*
Purpose	Strategic R&D activity with preset objectives	Strategy development through action	Operations development through increased knowledge	Problem solving by collaborative accomplishments
Organization	Network forms around an utilizer, who organizes action for rapid knowledge results	Network forms around a region (regional development) or a funded project (e.g., public funding)	Network forms around a provider organization(s)	Network initiated by users lacks formal coordination mechanisms
Action	Utilizer guides information collection from the users and promotes knowledge creation that supports the achievement of preset goals	Information is collected and used together and knowledge is co-created in the network	Information is collected for immediate or postponed use; new knowledge is based on the information that provider gets from the others	Information is not collected formally and builds upon users' interests; knowledge is utilized in the network to help the user community
Outcomes	New knowledge for product and business development	Guided strategy change into a preferred direction	New knowledge supporting operations development	Solutions to users' everyday-life problems
Lifespan	Short	Short/medium/long	Short/medium/long	Long

Source: Leminen, Westerlund, et al. (2012, p 8)

Schuurman (2015) stresses the importance of distinguishing researchers as a separate type of actors instead of providers/enablers because the contribution of academia goes beyond the user research, but it includes also research on technical topics related to the focus of the Living Lab, or policy and business research. Figure 6 illustrates the Living Lab constellation of actors proposed by Schuurman (2015).

Figure 6: The anatomy of a Living Lab constellation



Source: Schuurman (2015, p 195)

Context

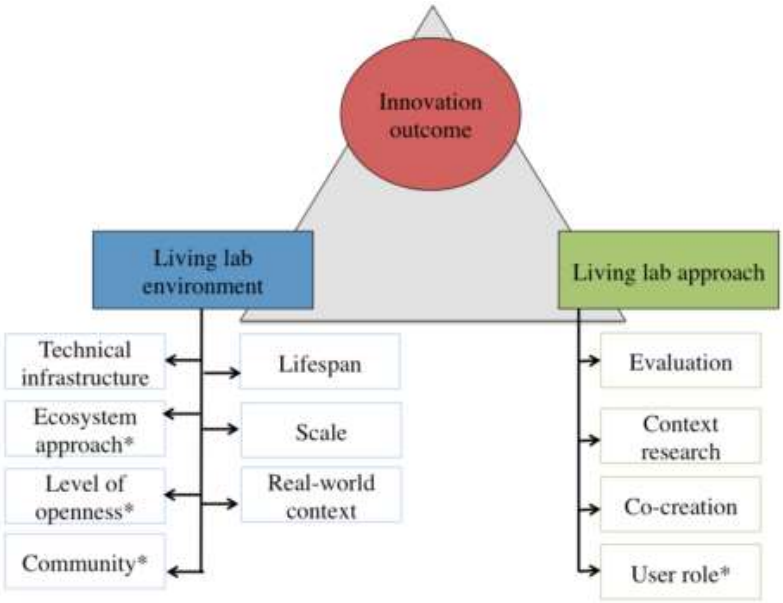
Living Labs are grounded in real-life setting since their emergence. The embeddedness of Living Labs in a real-life context contributes to foster the user interactive experimentation and the co-creation of new ideas since the aim is to apply them in real situation. However, to be enacted in a real-life context does not mean that Living Labs must be embedded in a physical region. They can also be a virtual reality (Juujärvi and Pesso, 2013). This is an intrinsic feature of Living Labs making it unique when compared to other methodologies oriented to innovation creation, such as test-bed and innovation lab. Living Labs differ from test-beds because the latter mostly produces one-shot testing projects in a controlled environment of a laboratory with a technological deterministic view whereas Living Lab is an organized approach (as opposed to an *ad hoc* approach) working on real-life settings (Westerlund and Leminen, 2011, Veeckman, Schuurman, et al., , 2013a, Schuurman, 2015).

Regarding Innovation Labs, Gryszkiewicz, Lykourentzou, et al. (2016, p 83) define them as "a semi-autonomous organisation that engages diverse participants - on a long-term basis - in open collaboration for the purpose of creating, elaborating, and prototyping radical solutions to open-ended systemic challenges." On the other hand, Schuurman and Tõnurist (2017) define Innovation Labs as islands of experimentation and limit their purpose to projects carried out by the public sector to test and scale out public service innovations. However, both researches agree about the level of autonomy required to facilitate the process of innovation development. Having these definitions as basis, one of the main differences between Living Labs and Innovation Labs remains their contexts. Whereas Living Labs aim to operate within a real-life context, Innovation Labs have a focus on ideation and experimentation that can happen regardless of context (Gryszkiewicz, Lykourentzou, et al., 2016, Schuurman and Tõnurist, 2017).

Main Characteristics

Having as foundation the characteristics proposed by Følstad (2008) and the key principles of good practice of Eriksson et al. (2005) and updating them with the help of new real-life empirical data, Veeckman et al. (2013b) developed a more comprehensive framework composed by 11 key characteristics divided into three pillars (Figure 7). The importance of this framework is to explore the link between the characteristics of Living Labs and the innovation outcomes and to take a step further to achieve a better implementation of this innovation instrument (Veeckman, Schuurman, et al., 2013b). The characteristics identified were divided on the generic level (the Living Lab environment) and on the project level (the Living Lab approach). The set of characteristics on the generic level refers to material, immaterial, and contextual elements of a living lab environment whereas the set on the project level defines the methodological aspects (Veeckman, Schuurman, et al., 2013b). The five original elements added by Veeckman et al. (2013b) in the framework are: *Ecosystem Approach, Level of Openness, Community aspect, User Role* and *Innovation Outcomes*.

Figure 7: The Living Lab triangle (*New building blocks)



Source: Veeckman, Schuurman, et al. (2013a, p 6)

The building blocks of the three pillars below are described in the Table 3. These elements on the framework will be further used to achieve a similar description focused on Urban Living Labs.

Table 3: Definition of the building blocks of Living Labs

Living Lab Environment	
Technical Infrastructure	Existence or not of technical infrastructure, with or without monitoring and technical testing, is an important aspect to focus on, since Living Labs and testbeds are often intertwined.
Ecosystem approach	Living Lab is an ecosystem on its own since various stakeholders interact to develop and evaluate a certain process, product or service.
Level of openness	The concept of openness within Living Labs can be analysed on different levels, for instance the degree of how intellectual property rights are being handled (sharing of knowledge) and the degree of embracing new (external) partners and through this establishing new partnerships.
Community	The users participating in the Living Lab compose a community, which can range from a community of interest to a community of practice, geographically bounded or not.
Lifespan and Scale	These two criteria refer to the duration (short, medium or long term) and the scale (small, medium or large) of the Living Labs projects.
Real-world context	It means that the context to the innovation process in the Living Labs are not simulations.
Living Lab Approach	
Evaluation	Existent in all Living Labs, the evaluation encompasses different types of feedback methods as well as different extents of comprehensiveness.
Context Research	It refers to the extent to which the Living Lab enables the participants to investigate the usage context.

Co-creation	It is one of the crucial aspects of Living Labs, a human-centric involvement and a collaborative method of operation represent one of the Living Lab criteria.
User's role	The four different user roles in Living Labs are *informant*, *tester*, *contributor* and *co-creator*.
Innovation Outcome	
Strategic intention	Different participants having individual or shared motivation to collaborate.
Passion	Passion for participation and collaboration within the ecosystem.
Knowledge and skills	The knowledge and skills of participants, with or without a certain expertise, in the Living Lab network.
Other resources	The amount and timing of (available) resources.
Partners in the LL network	The number of type of participants in the network.

Source: based on Veeckman, Schuurman, et al. (2013a) and Schuurman (2015) with modifications by author (2017)

Concluding the summary of the Living Labs characteristics scattered around scientific publications, the following Table 4 provides a combination of the key information previously presented on the topics:

Table 4: Summary of different findings on the characteristics of Living Labs

Topic	Summary		Authors
Goal	Open Innovation User Innovation		(Von Hippel, 2005, Chesbrough, 2006, Bergvall-Kåreborn, Eriksson, et al., , 2009, van Geenhuizen, 2016)
Activities	Pre-measurement	Contextualization *Co-creation* *Exploration* Selection *Concretization*	(Pierson and Lievens, 2005, Westerlund and Leminen, 2011, Almirall, Lee, et al., 2012, Schuurman, 2015)
	Intervention	Implementation *Experimentation*	
	Post-measurement	Feedback *Evaluation*	
Participants	Utilizer Enabler Provider Producer User Researcher		(Arnkil, Järvensivu, et al., 2010, Westerlund and Leminen, 2011, Juujärvi and Pesso, 2013, Schuurman, 2015)
Context	Real-world context		(Westerlund and Leminen, 2011, Veeckman, Schuurman, et al., , 2013a, Schuurman, 2015, Gryszkiewicz, Lykourentzou, et al., 2016, Schuurman and Tõnurist, 2017)

Topic	Summary	Authors
Main characteristics	Open and user innovation environment Real-life experimentation Multi-method Active user involvement Multistakeholder network	(Veeckman, Schuurman, et al., , 2013a, Schuurman, 2015)

Source: based on Pierson and Lievens (2005); Arnkil, Järvensivu, et al. (2010); Westerlund and Leminen (2011); Almirall, Lee, et al. (2012); Juujärvi and Pesso (2013); Veeckman, Schuurman, et al. (2013a) and Schuurman (2015) with modifications by author (2017)

What can be noticed observing the Table 4 is that the definition presented cover the main characteristics of Living Labs. The importance of this overview through a more general Living Labs approach is to provide a solid ground before starting the discussion about Urban Living Labs, since it is just one of the types of Living Labs and there are many conceptual overlaps between both.

3.3 Urban Living Labs

As cities are becoming more economically productive, they are facing growing social and environmental challenges regarding to the unsustainable urbanisation patterns and their consequences, for instance poverty, inequality, segregation as well as deterioration of the natural resources and aggravation of climate change (Voytenko, McCormick, et al., 2016). Although these problems are essentially in urban character, so are their solutions (Evans, Karvonen, et al., 2016).

As long as cities intend to transform themselves towards urban sustainability, this is a matter of changes in the ways in which provision and service systems are designed, organised and delivered in diverse urban contexts requiring a shift also in markets, practices, policy and culture (Voytenko, McCormick, et al., 2016). And urban experimentation is in the intersection between practice and theory offering a tool in the search for alternative ways to organise, plan, manage and live in cities (Evans, Karvonen, et al., 2016).

If Living Labs were previously mentioned as an approach to innovation consisting on real-life experimentation and active user involvement, so are Urban Living Labs situated in the fertile ground of the urban experimentation and co-production, actively involving the citizens in the creation of innovative urban solutions oriented to the main urban challenges that the contemporary cities are facing. According to Baccarne et al. (2014), Urban Living Lab is a useful framework to combine both top-down governance and bottom-up initiatives in the city. As it will be explained further, Urban Living Labs can be defined as an organized approach that aims to develop innovative urban solutions through multi-methods of real-life experimentation and learning applied in a geographical bounded space and active citizens involvement in the whole innovation process.

According Wallin (2014), there are more than 400 publications in scientific journals using Living Labs as their research approach, but only about one fourth represents studies on various knowledge fields such as social and decision sciences (e.g. urban development and governance), medicine and economics. The large remain part is focused in computer science and engineering. Once urban development is just one of the expertise fields addressed by Living Labs methodology, the academic literature on the Urban Living Lab topic has only emerged recently and there is no agreement neither in a common definition nor on the

fundamental role of ULLs in the co-production of urban innovative products and services. However, the perceived confusion around the concept does not avoid the Urban Living Labs have become a trend in cities all over the world being used to refer to a wide variety of local experimental projects of a participatory nature (Steen and Van Bueren, 2017).

As said earlier, co-creation is one of the main characteristics of Living Labs and when it is applied to the urban context it means an active involvement of citizens, beyond consultation, since the earliest stages of decision making process (Van Thiel, 2014). Like the companies and organizations in a competitive scenario pursuing a constant flow of novel ideas through emergent technologies started to pay attention to users as a source of valuable feedback and relevant user experiences (Westerlund and Leminen, 2011), also do the cities aiming to provide services that fits more efficiently in the needs of the citizens, to engage the citizens in the planning process or to allow them to give feedback for the local services/products (Juujärvi and Pesso, 2013, Nesti, 2015). With this contribution of the citizens the range of available solutions is wider, resulting in the innovation that the transition towards sustainability requires. For this reason, the Living Lab focused on sustainable urban transitions with people in their roles as citizens and not necessarily as users are defined by Schliwa and McCormick (2016) as C*itizen-Centric Living Labs* (CCLL) in opposition to *User-Centric Living Labs* (UCLL)[4].

3.3.1 Characterizing Urban Living Labs

This thesis has the aim to increase the theoretical and empirical knowledge about Urban Living Labs. Very heterogeneous cases of ULLs are studied together once there is no categorization based in their characteristics and types makes it harder to advance the researches about the added value of ULLs. Currently, there are few studies assessing the main characteristics of Urban Living Labs. As stated by Voytenko et al. (2016), there are many remain questions about the impacts and effectiveness of ULLs, not only in their own geographical domain as in broadly scales (urban, regional and national). Using as basis the description about Living Labs elaborated by Schuurman et al. (2015, p 12), the conclusion is that the literature regarding the ULLs "is rather silent and positions [Urban] Living Labs too much as an 'everything is possible' concept that resembles an empty box, in the sense that you can put whatever methodology or research approach inside."

The first step was to search in the available academic literature the shared characteristics of ULLs, clustering them on a table composed by the building blocks of Urban Living Labs. The most recent report about Urban Living Labs cases in Amsterdam, written by Steen and Van Bueren (2017) came up with a description of the main characteristics based on goals, activities, participants and context, as was done earlier with Living Labs (Table 5), that was complemented with information from other authors to create a broad overview of characteristics.

[4] The concept of *User-Centric Living Labs* presented by Schliwa and McCormick (2016, p 167) resembles that one raised in the topic *2.2. Living Labs*: "Living Labs that mostly target ICT product-service system development with people in their role as users."

Table 5: Characteristics of Urban Living Labs across several scholars

Characteristics		Definition
Goal	*Urban Innovation*	Developing new knowledge and products[5] into the environment of the ULL to find solutions to existing or new urban challenges.
	Open knowledge development and innovation for application	Producing and exchanging knowledge of the developed products and processes to achieve these products in a way as open as possible.
	Local sustainability innovations	Supported local solutions focused on promoting sustainable development.
Activities	*Co-creation*	The participating actors together give shape to the innovation process.
	Development of Innovation (exploration)	Living labs aim to develop an innovation or a product, and not only, for example, to test or implement a pre-developed solution.
	Experimentation and Learning	Experimentation under real-world conditions, co-producing knowledge and ideas with the users, including e.g. new forms of collaboration, employment, education, etc.
	Interaction between activities of evaluation and learning	The ability of ULLs to facilitate formalised learning amongst the participants. The feedback gathered from use and evaluation of the product by the participants under real world conditions is used to further develop the products.
Participants	*Users, private actors, public actors and knowledge institutes*	Actors from these four groups are active contributors to the innovation and development process taking place within a living lab.
	User Centred	The users are in the core of the process of planning and they appear in all the stages of the ULLs approach, participating and co-design with other stakeholders.
	Decision power	All participants, including the users, have decision power in the various stages of the innovation process.
Context	*Geographical Coverage*	The ULL situated in a geographical area where the processes in focus are taking place. This may be a region, an agglomeration, a city, a district or neighbourhood, a road or corridor, or a building. The area is normally well defined and has a manageable scale but the ultimate goal is to turn the whole city into a Living Lab.
	Real-life setting	The living lab activities are enacted in a real-life use context, producing new urban environments, practices, patterns, etc.

[5] "The product of a living lab can be an object (e.g., a solar panel), a service (e.g., waste recycling services), a technology (e.g., decentralized sanitation), an application (e.g., electric cars as energy storing systems at home), a process (e.g., a participative neighbourhood development method), or a system (e.g., a new logistic waste collection system)" (Steen and Van Bueren, 2017, p 10).

Characteristics		Definition
	Part of an Ecosystem	The ULL is part of the normal planning system and planning practices, covering cities or smaller units such as the transportation system. The ULL can be also part of the expanded urban planning when is embedded in the community development or local co-governance.
	Time Focus	Short vs long term actions, aiming to reach all the city with permanent changes of the urban environment.

Source: based on Friedrich, Karlsson, et al. (2013), Schliwa (2013), Wallin (2014), Voytenko, McCormick, et al., (2016), Wallin, Horelli, et al. (2017) and Steen and Van Bueren (2017) with modifications by author (2017)

Comparing the Living Labs and Urban Living Labs, having as basis Table 4 and Table 5, it is noticed some particularities of the later one, as summarized in the Table 6.

Table 6: Comparison between Living Lab and Urban Living Labs

Characteristic	Living Lab	Urban Living Lab
Goal	The main goal of a Living Lab is to deliver innovation, such as new knowledge, products or services, oriented to market challenges, in a way as open as possible and actively involving the users since the early stages.	An Urban Living Labs also aims to deliver innovation, such as new knowledge, products or services, however they are oriented to urban challenges. The knowledge about the products and the processes used to develop these products is exchanged in a way as open as possible.
Activities	The activities within a LL can be carried before, during or after the implementation. They are co-creation; exploration; experimentation and evaluation.	The activities in a ULL are equivalent to those conducted in a LL: co-creation, development of innovation, experimentation and learning and interaction between activities of evaluation and learning.
Participants	In a LL, the participants (Quadruple Helix) play different roles, as utilizers, enablers/providers, producers and users. The process of co-creation is centred in the user, but all actors must be producers. Utilizer is the one that seeks to take advantage in the process and enabler is the one providing the infrastructure.	Like the LL, the Quadruple Helix actors play different roles. However, in ULL the roles are more diffuse. User role is played by the citizens, that can also be the utilizers when they initiate the process. Public sector, private actors and knowledge institutes can act as enablers, providers or utilizers, but all of them must be producers and may share the decision power.
Context	Grounded in real-life setting, existing as a virtual reality or a physical region.	Grounded not only in a real-life setting, the ULL must be embedded in a geographical area.

Source: Author (2017)

3.3.2 Types of solution for urban challenges

The next step is to search in the available academic literature the several types of solutions for urban challenges identified by other researchers when studying Urban Living Labs, their methodology and their characteristics. The authors were clustered on the following theoretical segmentation, based on their attempts to conceptualize and classifying Urban Living Labs according to the type of approaches and solutions that they propose for dealing with urban challenges. It results on three categories of Urban Living Labs. Although those types were identified as different from each other, its known there is an overlap between them, due to of the variety of methods used to enhance participants and generate new solutions. For instance, one of the building blocks of Urban Living Lab approach is the focus on citizens as users. Even if the cases are not identified as citizen-driven Urban Living Labs, this feature will most likely be present, however it is not their main focus when developing their projects. The same is valid for cases not identified as transition-driven Urban Living Labs but they still have the sustainable development as a driver to their urban interventions. The technological orientation of Urban Living Labs can be either a tool to achieve sustainability goals or citizen empowerment or the aim of the projects, especially when the target is a smart city. The three types are bellow described. These labels (*technology-driven, citizen-driven, transition-driven*) were used to selected cases that fit on the description and present similarities with other cases previously identified by other authors.

The technology-driven Urban Living Lab

The first type of Urban Living Lab is described as *a technology-driven research environment* ranging from augmented reality-assisted research to city-wide test laboratories. This type of ULL is focused on collect information about the users on the artefact or service which has been used to improve the urban environment or/and local services (Wallin, Horelli, et al., 2017). There are several examples of cities using the Living Lab approach to enable the interaction with the citizens and knowledge exchange toward a smart city, envisioning cities as laboratories and drivers for change (Baccarne, Schuurman, et al., , 2014). Wallin, Horelli et al. (2017, p 32) argues the role of users is this type of ULLs "is that of an observed subject and not an engaged citizen in the co-creation of ideas and breakthrough scenarios". One of those technology-driven Urban Living Labs is The Green Village, an initiative of Delft University and the Stichting Green Village, in the city of Delft, The Netherlands, to accelerate the development and implementation of the radical innovations required to solve the world's largest challenges, in an experimental real-life housing setting (The Green Village, 2017a).

The transition-driven Urban Living Lab

Cities experiencing a transition require systematic changes in ways in which urban systems of provision and services are designed, organised and delivered, encompassing new technologies and infrastructures but also entailing shifts in practices, markets, policies and culture (Loorbach, 2007, Voytenko, McCormick, et al., 2016). There is a need for new institutions and arrangements, including new decision-making structures and designing differently the way the cities are planned and improved. On this issue, the third type of Urban Living Lab is focused on the transition towards sustainable urban development, since it constitutes a form of experimental governance, focused not only in technology but also in issues of consumption, behaviour and lifestyles (Voytenko, McCormick, et al., 2016). In this type of Urban Living Labs there is an emphasis in experimenting with new products/services situated in a geographical area and new decision-making processes.

The definition of Urban Living Lab as an ecosystem is used by Baccarne, Schuurman, et al. (2014) to speak about its collaborative nature which end-users and other stakeholders are involved in the creation of sustainable, future proof innovations to improve life in the city and boost the economy. Therefore, the following authors focusing their works in the networks built into Urban Living Labs as an opportunity to achieve urban governance in the formal and in the expanded planning system. First of all, Horelli, Saad-Sulonen et al. (2015, p 4) defines urban governance as "a wide set of institutions and interrelationships, which steer economic and social processes beyond the formal structure of local, regional or even cross-national government". Secondly, the expanded urban planning includes not only the traditional collaborative enabling tools to steer citizen involvement but also urban and community informatics[6] at different phases of the planning cycle (Horelli, Saad-Sulonen, et al., 2015).

In this scenario, this type of Urban Living Lab can work as *an arena for deliberation and a space for self-organizing groups* since it works to implement a new model of local governance, reaching these groups, that normally are detached from formal urban planning (Wallin, Horelli, et al., 2017), whereas includes the other stakeholders of the Quadruple Helix mode, bringing together science, policy, business and civil society (Bulkeley, Coenen, et al., 2016). To conclude, this type of Urban Living Lab allows systematic governance of stakeholder interactions and connect top-down policy and bottom-up initiatives (Baccarne, Schuurman, et al., , 2014). In this way, Urban Living Labs are being rapidly inserted into and overlaid onto existing urban governance structures, practices and networks in cities, especially across Europe (Voytenko, McCormick, et al., 2016). One example is the project TransformCity, an online dashboard that integrates a variety of methods to connect citizens, businesses, organizations and the government to exchange information and ideas to collectively plan, change and own the city or neighbourhood. Currently, the project is being tested in Amsterdam Southeast, the Netherlands [7].

However, this Urban Living Lab type is also situated in the boundaries between research, innovation and policy. In the literature that exposes Urban Living Labs as *a tool to enable urban experimentation*, there is an emphasis on the development and test of innovative urban interventions in a geographically bounded space under real-life setting (Friedrich, Karlsson, et al., 2013, Bulkeley, Coenen, et al., 2016, Bulkeley, Breitfuss, et al., 2015, Steen and Van Bueren, 2017). According to Schliwa (2013, p 64), Urban Living Labs with this approach "provides physical, institutional and financial space for innovative frontrunners from academia, governments, businesses and society to experiment with sustainable products and solutions in real-life, aside from the predominant regime and landscape of established rules, norms and infrastructures." In this way, Urban Living Lab differs from other urban innovation methods because of its place-explicit urban focus and because of its experimental feature towards future solutions and/or approaches while addressing current sustainability problem (Bulkeley, Breitfuss, et al., 2015). One example is the Living Lab Circular Buiksloterham, in an industrial area of Amsterdam, the Netherlands, where bottom-up experiments, research, culture and innovation were actively encouraged to develop a sustainable community (Steen and Van Bueren, 2017).

To conclude, it was observed this type of Urban Living Lab has examples that differ on the part of the process of planning they act. In the first example, the Urban Living Lab is focused

[6] Community informatics means the application of ICTs for community empowerment and urban informatics refer to the study, design, and practice of urban contexts that are created by ubiquitous technology (Horelli, Saad-Sulonen, et al., 2015).

[7] http://www.zocity.nl/

on the planning and discussion process whereas in the second example, it focuses on the implementation process. Despite this differentiation, both examples aim to enhance the transition towards sustainable cities, and are thus categorized under the same type.

The citizen-driven Urban Living Lab

Urban Living Labs can involve the citizens at different levels, from partners in the testing to give feedback to the local government about product effectiveness, to co-producers of services and products for the city (Nesti, 2015). Besides the technology-driven application of Urban Living Labs, some authors emphasize the potential of Urban Living Lab methodology to boost civic initiatives, empowering the citizens in the decision making and planning processes. With civic initiatives Meerkerk and Edelenbos (2016, p 2) refer to citizen or community driven bottom up initiatives, "which aim to deal with a specific set of public issues and which have the ambition to set up lasting cooperation among citizens aimed at production and local ownership of services or goods to improve their social and physical environment."

This type of Urban Living Lab works as *a tool for reaching the users and transforming the real urban environment* by encouraging the citizens to develop and produce urban artefacts (Wallin, Horelli, et al., 2017). Veeckman and van der Graaf (2015) are one of those authors considering in their research Urban Living Labs that specifically involve citizens in city development to make urban areas better suited to their needs and to generated public value. Franz (2015, p 56) gives an emphasis to Urban Living Lab oriented to co-developing cities and urban living environments, "an approach that generally includes catchwords such as empowerment, participation or co-creation and provides an open, participatory and do-it-yourself environment that includes citizens (users) and local actors (producers) as agents in processes of co-creation and improved living spaces." In this case, ULLs are a special platform that puts emphasis on residents and their communities as users, i.e. people who wants to solve their real-life problems, whereas the other actors should acknowledge the user ownership in the process (Juujärvi and Pesso, 2013). The cases analysed in this research consist in co-housing initiatives, where a group of local residents had the interest to develop an alternative community in terms of land ownership, architectural freedom, governance and/or local circular economy, with the final aim to achieve a resilient and sustainable way of life.

Types

What could be observed from this segmentation in the theory is how the three types concerning the kind of solutions that the ULL propose to urban challenges differ from each other and at the same time, they are overlapped. The first one, the technology-driven, is more oriented to develop and implement radical technology innovation to solve the largest urban challenges. The second type has as focus to direct involve the citizens in the decision making and planning processes, to boost civic initiatives and to empower and encourage them to develop and produce urban artefacts better suitable to their needs. The third identified type of Urban Living Lab is focused in the sustainable development and acts as responses to the main challenges of cities in the transition towards this objective. This is possible by building a solid network within Urban Living Labs projects, as an opportunity to achieve urban governance in the formal and in the expanded planning system while develop and test innovative urban interventions in a geographically bounded space within a real-life setting. In Table 7 below there is a summary of the three different interpretations of the Urban Living Labs types that emerged from the literature review:

Table 7: Theoretical Urban Living Labs segmentation into different types.

Label	Technology-driven	Transition-driven	Citizen-driven
Authors	(Baccarne, Schuurman, et al., , 2014, Juujärvi and Pesso, 2013, Wallin, Horelli, et al., 2017)	(Friedrich, Karlsson, et al., 2013, Schliwa, 2013, Baccarne, Schuurman, et al., , 2014, Bulkeley, Breitfuss, et al., 2015, Horelli, Saad-Sulonen, et al., 2015, Bulkeley, Coenen, et al., 2016, Voytenko, McCormick, et al., 2016, Wallin, Horelli, et al., 2017, Steen and Van Bueren, 2017)	(Juujärvi and Pesso, 2013, Franz, 2015, Veeckman and van der Graaf, 2015, Meerkerk and Edelenbos, 2016, Wallin, Horelli, et al., 2017)
Definition	A research environment to collect information about the users on the artefact or service which has been used to improve the urban environment or/and local services.	An ecosystem that connects different stakeholders, bringing together science, policy, business and civil society, to implement a new model of local governance, reaching self-organizing groups, normally detached from formal urban planning. It focuses on enhancing the transition towards sustainability by promoting urban experimentation, within a geographically bounded space emphasizing the development and test of innovative urban interventions.	A special platform that emphasize residents and their communities as users, meaning people who wants to solve their problems, whereas other actors acknowledge the user's ownership in the process.
Main Urban Outcome	Technological Innovation	Sustainable Development	Citizen Empowerment
Keywords	Smart city; smart citizen; technological solution.	Governance; urban experimentation, sustainable development; transition.	Civic initiatives; citizen empowerment; bottom-up; self-organization.

Source: based on Friedrich, Karlsson, et al. (2013); Juujärvi and Pesso (2013); Schliwa (2013); Baccarne, Schuurman, et al. (2014); Bulkeley, Breitfuss, et al. (2015); Franz (2015); Horelli, Saad-Sulonen, et al. (2015); Veeckman, and van der Graaf (2015); Bulkeley, Coenen, et al. (2016); Meerkerk and Edelenbos (2016); Voytenko, McCormick, et al., (2016); Steen and Van Bueren (2017); Wallin, Horelli, et al. (2017) with modifications by author (2017)

What can be concluded analysing the Table 7 is there are in the existing literature three types of Urban Living Labs related to how they approach urban challenges. The next step is to analyse their building blocks and to understand how these elements were applied in the case studies resulting in different configurations of Urban Living Labs. At last, in this chapter the concept of Urban Living Labs is derived from the definition of Living Labs previous presented combined with a review done into the more specific literature about the subject, as presented in the Annex I. The most frequent characteristics in the analysed ULL definitions (*Urban innovation/ Development of innovation; Experimentation and Learning; Users, private actors, public actors and knowledge institutes/User centred and Real-life use context*) were took into consideration to develop a novel definition used in this current research, as presented in the Box 2:

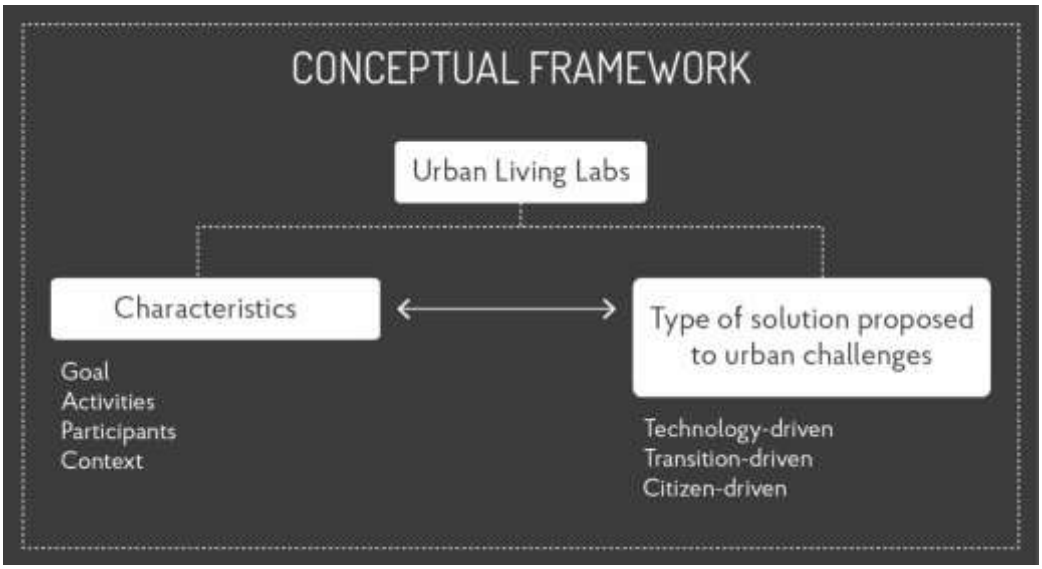
Box 2: Definition of Urban Living Lab

Urban Living Labs are an organized approach that aims to develop innovative urban solutions through multi-methods of real-life experimentation and learning applied in a geographically bounded space and active citizens involvement in the whole innovation process.

3.4 The Conceptual Framework

Despite the previously mentioned, main characteristics of Urban Living Labs are shared regarding their goals, activities, participants and context, the relationship between these characteristics and the identified three types of Urban Living Labs is still missing (Figure 8). To advance the studies about this theme, the research proposes to study the different characteristics looking how they are applied in practice, by analysing cases previously separated by their types, such as technological innovation, sustainable development or citizen empowerment.

Figure 8: Conceptual Framework



Source: Author (2017)

Chapter 4: Research Design and Methods 2

4.1 Introduction

This chapter explains the research methodology used to answer the two empirical research sub-questions and, consequently, the main research question. Since the research objective, the main question and the three first sub-question were already recapitulated in Chapter 2, this Chapter is focused on the research strategy, data collection and analysis methods adopted to conduct a ***Case Study***, using the theoretical findings discussed in the previous Chapter to developed them into empirical research by comparing multiple real cases, in order to test the theory developed.

4.2 Research Question

Empirical Research Sub-Questions

The last three sub-questions are empirical questions and required Case Studies to be answered as presented in Chapter 5:

1. *What main characteristics can be observed in Urban Living Labs in practice?*
2. *How do the various types of Urban Living Labs materialize in practice?*
3. *What patterns can be observed between the main characteristics and the types of Urban Living Labs?*

4.3 Research strategy

Case Study was the strategy chosen to test the theory and to produce new empirical knowledge about this young phenomenon. In this research, the Case Study strategy consisted in the examination in a real-life setting of multiple Urban Living Labs to observe how their main characteristics and types work in practice, resulting in a classification of the cases. Due to resourcing constraints this study could only draw a limited sample, as explained in section on Sampling (4.5). However, two cases were studied within each of the three identified classes, resulting in six different cases studied in-depth with great detail, rendering an extensive description of the Urban Living Lab phenomenon (Van Thiel, 2014). The cases studies are presented in Chapter 5.

4.4 Data Collection Methods

In Chapter 2 was explained that the *qualitative* approach was used because the current research deals with a new phenomenon. The first step explained was *Secondary Qualitative Data Collection*. Below, the second step is described and summarized on Table 8.

Case Study Research

1. Primary Qualitative Data Collection

a) Content analysis: This method entails the analysis of written or printed sources, such as reports, website pages, legal documents, newsletters, periodicals, promotional material, minute of meetings between stakeholders of the Urban Living Labs, i.e. raw data that was not analysed by other researchers. This method fits well in this exploratory research. All the information that could help to answer (entirely or partially) one of the guiding questions was saved and upload on Atlas.ti. The files were organized by groups

named following the rule *Focus – ULL name*[8]. To choose the relevant data about the cases the following actions were taken:

- First search was done on the official website of the case. If the initiative has more than one active projects, a special attention was given to general information (*Homepage*, *Vision*, *About us*, *History*, etc.). The website of the existing initiatives managed by the ULL were consulted also looking for overall information regarding the main organization;
- Other data sources found in the official page of the ULL were explored, such as social media. This step is important to triangulate the data regarding activities, since invitations, photographic and video records are available on these media sources. Another information possible to be triangulated through these medias is the range of actors participating in the activities, by looking for evidences of the presence of different social groups;
- When available the names of the partners (private companies, public sector, knowledge institutions, NGOs, civic organizations, etc.) in the official website of the case study, their official website pages were scrutinized to find in their database to look for any new information published there. The importance of this step is to compare different partners' points of view about the projects;
- Search via search engines for other sources besides the ones previously found, like interviews or descriptive pages in relevant websites (urbanism oriented websites, knowledge institutions, etc.);

b) Interviews: For this primary data collection method, in-depth semi-structured was used. Considering the time necessary to analyse all the data gathered in this kind of interview, the option chosen was to conduct interviews with a purposive sample, meaning the interviews are conducted only with independent experts and key actors, those with knowledge from inside the selected Urban Living Labs. The interviews can be conducted face-to-face or not, as long as the interviews can be recorded and transcribed for later analysis. The questions previously prepared using the operationalization of the concepts guided the interviews and they are similar to all respondents, although the semi-structured interview has space for more flexibility and improvisation. The list of questions can be founded on the Operationalization Table;

c) Observation: To answer questions regarding to the location and geographical coverage, the author visited the cases situated in The Netherlands to observe their current situation in the site where the activities of the Urban Living Lab have been carried out and to triangulate the information found using other sources.

2. Secondary Qualitative Data Collection

a) Academic Literature Review: The data required to identify the characteristics of the Urban Living Labs has mainly a descriptive character. Because of that, an analysis of existing empirical researches, collected, produced and/or published by other authors about the selected cases aims to achieve a saturation point, i.e. when is possible to answer all the guiding questions using the coded data or there is no new information that can be found via desk research and the data becomes repetitive. While doing the selection, the author was aware of which variables to concentrate in this research situation, i.e. literature presenting the characteristics of the six cases. To find relevant

[8] Six Document Groups: Citizen – Living Lab Habitat; Citizen – Vrijburcht Community; Technology – Eindhoven Stratumseind 2.0 Living Lab; Technology – The Green Village; Transition – Living Lab Circular Buiksloterham; Transition – ZoHo.

empirical literature about the Urban Living Lab phenomenon the following actions were taken:

- Search via academic databases[9] and search engines[10] for articles where the name of the case study were mentioned (the date and the amount of results will be explained later per case);
- The articles selected were case studies published by other authors.

Table 8: Empirical Research Methodology

Strategy	Data	Method	Approach	Variants	Analysis	Output
Comparative Multiple Cases Study	Primary	Interview	Choose a purposive sample composed by with independent experts and key actors and ask them open-ended questions	Open-ended interview Semi-structured interview	Recording followed by textual and software supported analysis of the transcription of the interviews	Empirical findings (Ch. 5) Final results (Ch. 6)
		Content Analysis	Interpreting the content of secondary data	Thematic ordering and coding	Textual and software (*Atlas.ti*) supported analysis	
	Secondary	Desk research	Analysis of the relevant academic literature specifically about the selected ULL cases	Thematic ordering and coding	Textual and software (*Atlas.ti*) supported analysis	

Source: based on Van Thiel (2014) with modifications by author (2017)

The combination of primary and secondary qualitative data is the most efficient way to triangulate the information and to achieve reliability and validity during the data collection and analysis steps in this thesis.

4.5 Sampling

In this research, it is not possible to assess all Urban Living Lab projects and their stakeholders, so a selection of a sample (n) from the total population (N) was necessary (Van Thiel, 2014). The selected cases are important to illustrate what was found in the literature review, considering that the research aims to explain how the characteristics identified through the theoretical review are applied in the real cases and if a relation can be established between these characteristics and the types concerning the kind of solutions that they propose to urban challenges. Bearing this is mind, the interview questions must be carefully prepared and conducted to identify these characteristics during the conversation. There is a set of heterogeneous cases to each one of the three types of Urban Living Labs to try to ascertain how they affect and are affected by the variation of the characteristics. In reaching this conclusion, academic theoretical and empirical literature about several examples of Urban Living Labs were read and also their own documents and promotional material, such as websites and social media. Thereafter, six cases were selected based on how they fit in the description of the three labels described in the literature review. Each case has two cases selected as example. It is

[9] Academia (academia.edu); Erasmus University Database (eur.nl/ub/); ResearchGate (researchgate.net); ScienceDirect (sciencedirect.com); Scielo (scielo.org); TimReview (timreview.ca);

[10] Google Scholar (scholar.google.com).

understood that there is an overlap between the three identified types of Urban Living Labs, what is discussed on Chapter 5. Having said that, the selection of the following six cases, guided by theoretical arguments developed in the literature review, is presented in the Table 9:

Table 9: Sampling

Types	Keywords	Cases	Overview	Data Collection Methods	Data type
The technology-driven Urban Living Labs	Smart city; smart citizen; technological solution.	The Green Village (NL)	A Living Lab aiming to accelerate the development and implementation of radical technological innovation (The Green Village, 2017a).	Guided tour Observation Secondary data	Primary Secondary
		Stratumseind 2.0 (NL)	Stratumseind is a Living Lab where massive amounts of data about people's activities is used to determine the effects of measures and to study which factors contribute to violence and discomfort. (ENoLL, 2017a).	Observation Secondary data	Primary Secondary
The transition-driven Urban Living Labs	Governance; urban experimentation, sustainable development; transition.	ZOHO (NL)	A well located former business area made for and by makers in design, art, culture, media, tech, food, architecture and urban planning to develop innovative solutions (ZOHO, 2017c).	Semi-structured in-depth interview Observation Secondary data	Primary Secondary
		Living Lab Circular Buiksloterham (NL)	A former industrial area, being transformed into a sustainable area to live and work, based on circular principles (Amsterdam Smart City, 2016a).	Semi-structured in-depth interview Observation Secondary data	Primary Secondary
The citizen-driven Urban Living Labs	Civic initiatives; citizen empowerment; bottom-up; self-organization.	Living Lab Habitat (BR)	A social network ecosystem for R&D and Education, with the purpose to develop and apply environmental friendly technologies in collaboration with low-income communities, aiming to contribute to supply the basic human needs (ENoLL, n.d.).	Semi-structured in-depth interview Secondary data	Primary Secondary

Types	Keywords	Cases	Overview	Data Collection Methods	Data type
		Vrijburcht Community (NL)	A "Collective Private Commissioning" that consists in a group of families who team up and created a foundation in order to share the costs, design and build their project according to their own criteria (Peborde, I., 2016a).	Semi-structured in-depth interview Observation Secondary data	Primary Secondary

Source: The Green Village (2017a), ENoLL (2017a), ZOHO (2017c), Amsterdam Smart City (2016a), ENoLL (n.d.), Peborde, I (2016a) with modifications by author (2017)

The most suitable interview sampling for qualitative data collection is the purposive type of sampling, meaning a selection of respondents who are supposed to have the most significant knowledge about the research topic. In this research, the six cases were studied using secondary and primary data collected by desk research and, for five of them, interviews were conducted to compliment and triangulate the data. Regarding the selection of respondents, triangulation of methods and sources was used to help in the identification of actors who played an essential role in the ULL. The total sample achieved was five respondents, each one from a different case. A saturation point was reached during the interviews, with new information to compliment the one found through desk research. The researcher had the opportunity to interview 4 experts who work for organizations that are directly involved in following ULL: 1 from Metabolic (CB), 1 from ZOHOCitizens (ZH), 1 from Federal University of Espírito Santo (LLH) and 1 from Vrijburcht Stichting (VC). An extra source considered was a researcher from TU Delft who provided a guided tour in the Green Village (GV) (

Table 10). All of them were identified through ULL institutional websites or through snowballing among other participants of the same initiative. The interviews were primary qualitative data collection and they were conducted during the months of October and November of 2017, by the research, in person or by video message. The duration of the interviews varied between 47 and 69 minutes.

Table 10: List of respondents

Code	Quota	Respondent's description	Source	Interview duration	Data
VC	Expert	Landscape architect	Secondary Data	70 minutes	26/10/2017
LLH	Expert	Researcher from Federal University of Espírito Santo	Secondary Data	47 minutes	01/11/2017
CB	Expert	Intern from Metabolic	Secondary Data	50 minutes	07/11/2017
ZH	Expert	Landscape architect	Snowballing	57 minutes	08/11/2017
GV (guided tour)	Expert	Researcher from TU Delft	Secondary Data	30 minutes (recorded part of the guided tour)	11/11/2017

Source: Author (2017)

4.6 Validity and Reliability

Validity and Reliability are important criteria to be addressed in a scientific research. To achieve a valid research what matters is a solid conceptual framework, on which is presented an existing relationship between the variables, a coherent operationalization of the concepts into the interview questions and a sound set of measurement instruments. There are two basic types of validity, namely internal and external. Internal validity means that the research measures what was intended to measure. To ensure the internal validity the triangulation technique was used to double check the data collected and research results. For that, the triangulation of data was applied by choosing indicators based on academic theory, comparing different researchers' theories and gathering and comparing information through interviewed people as well analysing documents (Van Thiel, 2014).

External validity refers to the ability to generalize the study to other situations, what is limited when it comes to qualitative research and case studies (Van Thiel, 2014). For this research, in the first place, an analytical generalization was made by selecting the cases applying the theoretical model of Urban Living Labs types developed in Chapter 3. Secondly, the results of the cases study are used, with adjustments, to validate and improve the theory serving as building blocks to further studies about the subject, as shown in Chapters 5 and 6.

Reliability is achieved when the variables are accurately and consistently measured, eliminating the possibility of coincidental findings. For that, the study of the cases was conducted as systematic a manner as possible, making possible a review of the process afterwards. The standardization of the methodology to study the cases allows replication and leads to the aimed meta-analysis (Van Thiel, 2014). Due to time and resource limitation to study a broader number of Urban Living Labs cases, the ones selected were deep analysed, using different sources to triangulate the data, mainly academic literature (researches), documents and other primary sources (reports, website, news, social media, etc) and interviews (participants and experts).

4.7 Data Analysis Methods

The secondary qualitative data obtained through literature review is used to better understand the subject and what is already known about Urban Living Labs. Also, the literature review guided the selection of the material, since the author has knowledge about the variables the search should be focused, in this case, the Urban Living Labs characteristics. However, when doing the analysis, the cases were separated into the different types. The relevant existing material selected, as already explained, was analyzed manually and used to operationalize the information used to study the cases and to improve the interview questions. The used literature was analyzed line-by-line to find key words or phrases related to the subjects under investigation. The important words, phrases or sections were highlighted and labelled, in a process called coding done using the software Atlas.ti, which is a tool for qualitative analysis. The code is a label created to divide the data into small units and describe the meaning of a specific part of the data (Van Thiel, 2014). For this research, the subjects that were relevant and where codes[11] were linked to are the characteristics of the three kinds of Urban Living

[11] The codes were created having the characteristics of ULL and basic information we are looking for as basis. In total 20 codes were created: Profile: description; when; how; where; why; initiator. Goals: urban innovation; open knowledge development and innovation for application; local sustainability innovations. Activities: co-creation; development of innovation (exploration); experimentation and learning; iteration between activities of evaluation and learning. Participants: users, private actors, public actors and knowledge institutes; user centred; decision power. Context: geographical coverage; real-life setting; part of an ecosystem; time focus.

Labs. The creation of codes was based on the variables and sub-variables of the conceptual framework (

Figure 8). This process was done to make possible a comparison between the cases pertaining the same group regarding their types of solutions, extracting from the data the patterns needed to understand the relationship between characteristics and types of Urban Living Labs.

The primary qualitative data provided through semi-structured interviews will be recorded, with authorization of the respondents. This approach was chosen because it leaves the interviewer free during the conversation to focus on the discussion. After the fieldwork, the interviews will be manually transcribed and then assessed, looking for important concepts previously operationalized. After that, the transcription will be coded. The analysis of the interview coding consists in selecting codes and making connections between them. The Annex II presents a comprehensive table that guided the coding process, with a list of the used codes and concepts. Basic information regarding historical overview, timespan and scale are also coded to provide a more complete profile of the Urban Living Labs. Finally, the findings were interpreted, and the results were presented in Chapter 5.

4.8 Operationalization: Variables, Indicators

The Operationalization table below (Table 11) shows how the concepts, indicators and variables in this research were operationalized, transforming them into questions not only to be asked during the interviews but also to guide the data collection using other secondary and primary data sources. The concepts, indicators and questions were formulated based on the research (sub) questions and on the literature review. The Urban Living Labs characteristics are the variables, sub-variables and indicators used to "measure" each one of the three types, differentiating them from each other. The table consists in the operationalization of the two main concepts into variables, sub-variables and questions. The first concept is ***Urban Living Lab characteristics***. Regarding the second concept, the different ***Urban Living Lab Types*** were based in the theoretical segmentation found, as presented in the previous Chapter.

Table 11: Operationalization

What is the relationship between the characteristics (1) and the types (2) (concerning the kind of solutions that they propose to urban challenges) of different Urban Living Labs and how can Urban Living Labs be classified based upon those?			
(1) Urban Living Lab Characteristics			
Variables	**Sub-variables**	**Definition**	**Guiding questions**
Profile	-	Basic information to locate the Living Lab in time and space.	- When, how, where and why did the ULL start? - From whom did the initiative start?
Goal	*Urban Innovation*	Developing new knowledge and products[12] into the environment of the ULL to find solutions to existing or new urban challenges.	- What is the current main goal of this ULL? - Does the ULL have more than one project? What are the guidelines to select a new project to start? - Does this ULL develop new knowledge and products? If so, what kind of? For whom? - Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion? - How does the ULL contribute to sustainable urban development, if at all?
	Open knowledge development and innovation for application	Producing and exchanging knowledge of the developed products and processes to achieve these products in a way as open as possible.	
	Local sustainability innovations	Supported local solutions focused on promoting sustainable development.	
Activities	*Co-creation*	The participating actors together give shape to the innovation process.	- What are the different roles (enabler, provider, utilizer, user or researcher) performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized? - What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?
	Development of Innovation (exploration)	Living labs aim to develop an innovation or a product, and not only, for example, to test or implement a pre-developed solution.	
	Experimentation and Learning	Experimentation under real-world conditions, co-producing knowledge and ideas with the users, including e.g. new forms of collaboration, employment, education, etc.	

[12] "The product of a living lab can be an object (e.g., a solar panel), a service (e.g., waste recycling services), a technology (e.g., decentralized sanitation), an application (e.g., electric cars as energy storing systems at home), a process (e.g., a participative neighbourhood development method), or a system (e.g., a new logistic waste collection system)" (Steen and Van Bueren, 2017, p 10).

	Interaction between activities of evaluation and learning	The ability of ULLs to facilitate formalised learning amongst the participants. The feedback gathered from use and evaluation of the product by the participants under real world conditions is used to further develop the products.	- Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom? - Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?
Participants	*Users, private actors, public actors and knowledge institutes*	Actors from these four groups are active contributors to the innovation and development process taking place within a living lab.	- Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)? - How many participants are involved in total (per group)? - Are the citizens actively participating in all the stages of the processes taking place in the ULL? - Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?
	User Centred	The users are in the core of the process of planning and they appear in all the stages of the ULLs approach, participating and co-design with other stakeholders.	
	Decision power	All participants, including the users, have decision power in the various stages of the innovation process.	
Context	*Geographical Coverage*	The ULL situated in a geographical area where the processes in focus are taking place. This may be a region, an agglomeration, a city, a district or neighbourhood, a road or corridor, or a building. The area is normally well defined and has a manageable scale but the ultimate goal is to turn the whole city into a Living Lab.	- Where does the activities of the ULL take place? - Is the ULL supported by the Local Government? Does it have an official status? - Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)? - How long has the ULL been active? What is the average duration of a project?
	Real-life Setting	The living lab activities are enacted in a real-life use context, producing new urban environments, practices, patterns, etc.	
	Part of an Ecosystem	The ULL is part of the normal planning system and planning practices, covering cities or smaller units such as the transportation system. The ULL can be also part of the expanded urban planning when is embedded in the community development or local co-governance.	
	Time Focus	Short vs long term actions, aiming to reach all the city with permanent changes of the urban environment.	

(2) Types	
Variables	**Definition**
Technology-driven	A research environment to collect information about the users on the artefact or service which has been used to improve the urban environment or/and local services.

Citizen-driven	A special platform that puts emphasis on residents and their communities as users, meaning people who wants to solve their problems, whereas the other actors should acknowledge the user ownership in the process.
Transition-driven	An ecosystem that connect different stakeholders, bringing together science, policy, business and civil society, to implement a new model of local governance, reaching self-organizing, that normally are detached from formal urban planning. The aim is to enhance the transition towards sustainability by promoting urban experimentation, with an emphasis on the development and test of innovative urban interventions in a geographically bounded space within a real-life setting.

Source: based on Veeckman, Schuurman, et al. (2013a) and Marvin and Silver (2016) with modifications by author (2017)

Chapter 5: Empirical Results

5.1 Introduction

This chapter presents an insight of empirical findings of the following Urban Living Labs: The Green Village, Eindhoven Stratumseind 2.0 Living Lab, ZOHO, Living Lab Circular Buiksloterham, Living Lab Habitat and Vrijburcht Community. It focuses on the practical application of the ULL characteristics in the cases, highlighting the similarities and differences between cases belonging to the same group regarding their types. The variables subject to discussion are the characteristics and its relationship with the types. The chapter interprets and examines findings of the coding done in all the data collected, including vivid information gathered through in-depth semi-structured interviews with participants from inside the Urban Living Labs projects. This chapter is divided per types and each section begins with a brief profile from the cases to be analysed. The qualitative analysis of data attained is presented with tables, aiming to answer the three empirical sub-questions of this research:

3. *What main characteristics can be observed in Urban Living Labs in practice?*

To answer this question, the characteristics of the Urban Living Labs were searched in the available literature and empirical studies about them, observed by the author in on-site visit and/or were asked in the interviews. The results are presented as a short descriptive text followed by an infographic summarizing the main findings. A complete table for each one of the cases compiling all the gathered information with respective sources is available in the Annex III.

4. *How do the various types of Urban Living Labs materialize in practice?*

To understand how the three types are translated into real-life projects, first the cases were analysed comparing their characteristics with the theory that has been developed throughout this thesis. The section was organized by variables (*goal, activities, participants and context*) since they are used afterwards to compare the cases.

5. *What patterns can be observed between the main characteristics and the types of Urban Living Labs?*

This question was answered by comparing both cases under the same category in order to discover similarities between them and develop a definition for the focus covering the cases studied and which may be considered in future researches. Also, the results were analysed to spot a reliable explanation for the differences found though literature review for the three types.

5.2 Technology-driven

As explained, the first type of Urban Living Lab is *a technology-driven research environment* focused on data collection about how users interact with an artefact or a service which has been used to improve the urban environment and/or local services. The two cases selected to represent this type are The Green Village and Stratumseind 2.0, both situated in The Netherlands. The first one is part of Delft University of Technology (TU Delft) activities to stablish a bridge between fundamental research and application of large-scale innovation in real-life settings. The second one is located in the main nightlife street of Eindhoven, where new technologies are being applied in a real-life context to discover how lighting can impact in how people behave and to improve safety in the public space.

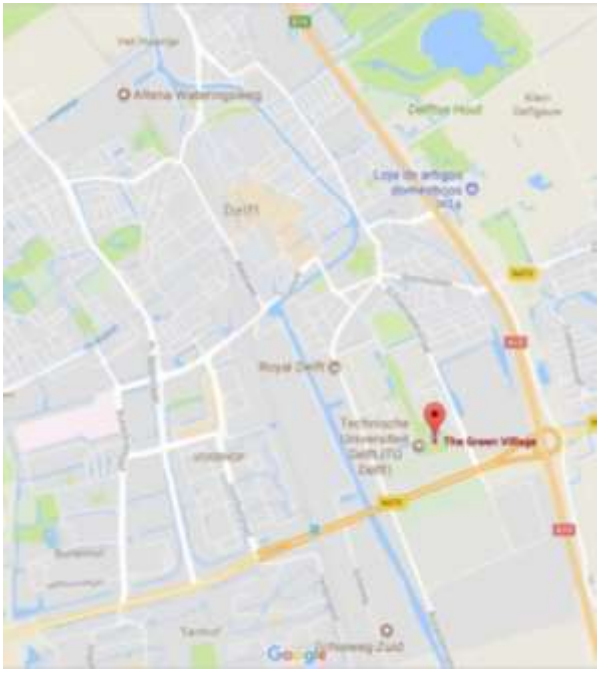
5.2.1 The Green Village (Delft, NL)

The first case of technology-driven ULL to be analysed takes place in Delft (Figure 9), which is a municipality situated in the province of South Holland, The Netherlands, to the south of The Hague and north of Rotterdam. The Green Village (Figure 10) is an Urban Living Lab, part of the TU Delft development, in collaboration with the Stichting Green Village; a project initiated in 2016 consisting in a site located inside the university campus, with flexible layout including landscaping, utility connections and robust paving (TU Delft, 2017) (Figure 11). It intends to occupy a key position in the chain from fundamental research to development and application of large-scale innovations in real-life by providing ground for research into sustainable new technologies (The Green Village, 2017a).

Observation is one of the data collection methods used in this research. The Green Village was visited on 11th November of 2017, to observe how the projects are currently placed in the site. The author accompanied a guided tour provided by one of the team members who designed a project named "Prêt-a-Loger", a sustainable renovation concept. The information gathered during the tour was also used to triangulate the data. It was noticed that several projects listed in the website could not be observed during the visit, either there were not installed there yet, they do not have physical demonstration, or they already were dismantled, due to their temporary character.

Goal

Figure 9: Location The Green Village



Source: Google Maps (2017c)

Figure 10: Logo The Green Village

THE GREEN VILLAGE

Source: The Green Village (n.d.)

Figure 11: The Green Village site on TU Delft campus

Source: Author (2017)

An Urban Living Labs has as goal to deliver innovation, such as new knowledge, products or services, however oriented to urban challenges, in a way as open as possible. In the Green Village, the final goal is to accelerate the development and implementation of radical innovations required to solve the world's largest challenges, contributing to a sustainable future (The Green Village, 2017a). This way, it works as a test bed (innovation site) for new breakthroughs related to water, circular economy, energy, buildings, outsmart and car as a plant power. It is expected these technologies contribute to a sustainable urban future since they are oriented to make a more sustainable use of resources, for instance to produce clean energy, to use waste as a resource, to produce clean water and to produce clean air (Koppers, 2015, van

Wijk, 2013). This is done by involving several collaborating actors that present, demonstrate and test their researched future technologies in a real-life environment. Several projects are being carried out in the Green Village site, focusing on innovations related to the living environment and societal challenges, pushing the current existing views regarding technologies, business models, public opinion, legislation and regulations (Geemente Delft, 2017a). The Green Village offers an ecosystem that facilitates the exchange of knowledge between companies and researchers since the projects implemented on site are available for other actors' appreciation and contribution with their own researches (Figure 12). The result is a higher level of innovation inside the ecosystem. Partners from outside also contribute in the projects with practical knowledge.

Figure 12: Combination of projects in the site of The Green Village (Car as Power Plant + Mini Smart Grid)

Source: Author (2017)

Activities

The activities carried out in an Urban Living Lab are divided in co-creation and development of innovation (before the implementation), experimentation and learning (during the implementation) and evaluation (after the implementation). As described in detail in the Table 22 presented in Annex III, there are several actors, from the four groups of the Quadruple Helix (private sector, public sector, civil society and knowledge institution) who co-create in The Green Village performing different roles and bringing resources with them and then together they give shape to the innovation process.

There is an exploration for new products and services in the field of sustainable energy provision, water and waste systems and also there is room for experimentation with business models. Because of the cooperation between scientists and entrepreneurs, their ideas and visions can be turned into experiences and commercially viable products and services. The experimentation in the ULL has two approaches: the first one is by creating research programs and the second way is through the physical demonstration site. TU Delft researchers are responsible for the research programs, subsequently modifying them into applied research. The researchers from the TU Delft are scientists, students and PhD candidates. The physical demonstration site needs a dynamic character because the projects are continuously under transformation (Koppers, 2015).

The evaluation phase is accomplished when the activities of visitors are registered on their interaction with demonstrated technologies. The data is collected and thereafter it is

investigated using questionnaires, interviews and market research (Koppers, 2015). For instance, DUWO, a partner student housing corporation in the Living Lab project, wants to investigate flexible living spaces, innovations in the field of management, energy consumption and operation of methods and models in real life, assuring that innovations are subject to real usage, real consumption and real feedback.

Participants

Even though a complete description of the roles of the participants is presented in the topic *3.1. Co-Creation* of the Table 18, here it is presented as part of the Participants topic, because this way the societal groups the actors come from and their roles can be contemplated together. Delft University of Technology (TU Delft) is the provider organization who offers the infrastructure in the campus, financial support and other necessary resources to the use of participants. Since the provider is also the initiator, it can be labelled as a provider-driven Urban Living Lab, characterized by having a network formed around the provider organization. Other providers are national and regional funding sources. The enablers in The Green Village bring tools, knowledge and methods for the research, a role is performed by organizations and the Municipality of Delft, who allows specific projects to be implement out of the current regulation boundaries. TU Delft through its students and researchers is also a utilizer seeking knowledge gains from the innovation process. However, the main utilizers are the companies who are developing and testing their technologies in the site, and mainly, receiving feedback from the users. The users are invited to contribute in the innovation process by giving input and providing feedback about their experience with the technologies (Koppers, 2015).

The flexibility in the roles performed by the same actor can be explained by the diversity of projects, each of them with a unique configuration of funding sources, network and outcomes. In fact, this is characteristic of Urban Living Labs: more diffuse roles played by the participants. A more comprehensive overview of the complex network arranged around the projects carried out in The Green Village is provided in the Infographic 1. The participants in the projects being carried out in The Green Village were identified through desk research, however during a visit in the site, it was notice identification boards in front of the projects where some new actors were listed. Because of the number of projects and the complexity of the networks stablished in the Urban Living Lab, some actor can be missing in the Infographic 1.

Context

An Urban Living Lab is grounded not only in a real-life setting, but it must be embedded in a geographical area. In this aspect, the performance of The Green Village as an Urban Living Lab leaves something to be desired. As it is an outdoor laboratory located in the TU Delft campus, the projects are being implemented in an environment that *simulates* real-life features, however it still is a controlled test-bed, where regulations are more flexible, and the initiator institution has the bigger stake as provider of facilities and funding. Having said that, the geographical coverage of the ULL is a demonstration site with offices, shops, houses, streets and lighting system covering a surface area of approximately 11,800m².

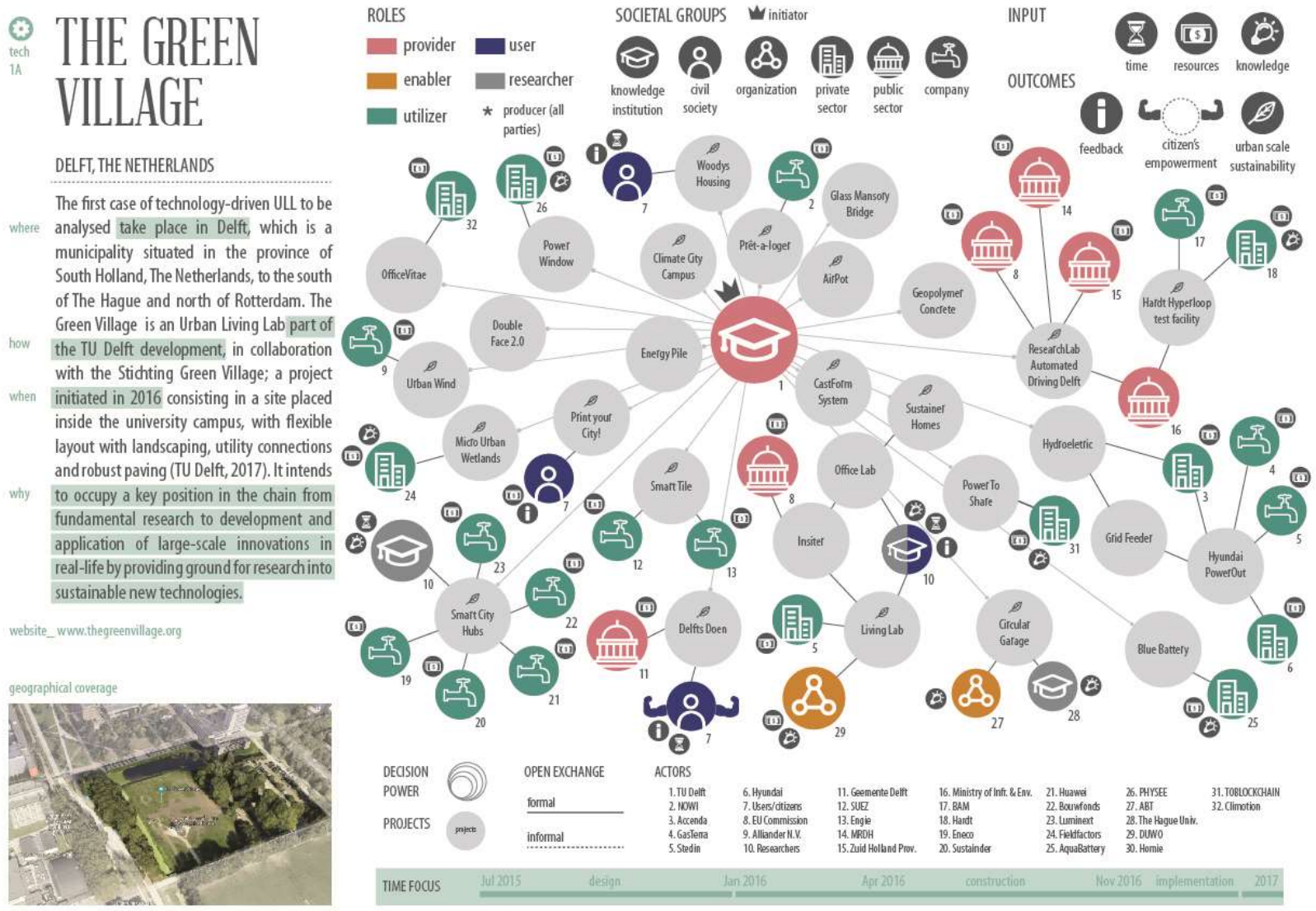
The real-life setting is ensured by the participants who bring real cases, challenges and feedback. It is important to mention the newly built student housing, where the residents will be monitored in their daily usage of appliances and systems there installed. Concerning the participation of the local government in the ULL it has an official status since several public-sector actors' support with funding and legal arranges. Also, the Municipality of Delft became a utilizer of the platform in the project *Delfts Doen*, a trial for the Environmental Law 2019

with active involvement of citizens in order to make them to better address their needs and to gain from their contribution with ideas.

Why is The Green Village a technology-driven ULL?

After having analysed the variables *goal*, *activities*, *participants* and *context*, it was possible to define The Green Village as an actual Urban Living Lab. Although its geographical coverage is limited to a demonstration site, it has real-life features and users, and the innovation developed in the area aims not only to be commercially viable, but more sustainable and suitable to the user's needs. In conclusion, because the GV works as an outdoor laboratory where technology is being tested with active involvement of users, especially regarding feedback gathering, The Green Village fits in the previously presented description of *technology-driven* ULL.

Infographic 1: The Green Village



Source: Author (2017)

5.2.2 Stratumseind 2.0 (NL)

Stratumseind is a street located in the centrum in the city of Eindhoven (Figure 13), with mainly pubs running through its 250 meter-long. As many entertainment districts, incidents were frequent, such as fights and criminal behaviour, resulting in reduced turnover to the business, neglected buildings and less pedestrians in the street. Due to the decline in the number of visitors, the Municipality of Eindhoven (Figure 14) decided to consult local stakeholders in biweekly meetings and as result of this consultation the idea of Stratumseind 2.0 was born. In December of 2013, the area received the Urban Living Lab, which involved entrepreneurs, breweries, property owners, police and city council to conduct research and experimentation related to many aspects of human behaviour aiming improve the safety in the Stratumseind street. The site was visited during the evening of 25th October, between 18:00 and 19:00 (Figure 15). During the visit, the opening time of the bars and the number of users were observed. The visit occurred during this interval between closing of the daytime activities and opening hour of the night activities, thus, few users were using the public spaces in the street at that time. Other external factors that could influence in this influx of people are weather and day of the week, since it was a rainy Wednesday evening. Based on the observation, the conclusion is most of the activities happen at night creating moments throughout the day of emptiness and unattractiveness in the street, being one of the problems to be solved through the strategies adopted by the ULL.

Figure 13: Location Stratumseind 2.0

Source: Google Maps (2017c)

Figure 14: Logo Geemente Eindhoven

EINDHOVEN

Source: Geemente Eindhoven (n.d.)

Figure 15: Stratumseind Street during the evening

Source: Author (2017)

Goal

The main goal of Stratumseind 2.0 goes beyond open innovation. It also includes to improve and increase the economic and social activities on Stratumseind making the street more safe, liveable and attractive. The use of interactive lighting is the response of the ULL local actors to the challenges the street has been facing regarding escalating behaviour. The “smart

technology" approach adopted in the area by the Municipality, such as sensors and cameras to control the activities, is utilized not only to gain insights into safety and privacy topics but also to further develop and "brand" Eindhoven as Smart City (Ruijsink, 2017). Since 2010, the label Eindhoven Living Lab has been used to name several initiatives spread across the city, being Stratumseind 2.0 one of them. Although several experiments are being carried out by using sensors, cameras and other instruments that collect the data, they are collected and processed together in a small office located in the street itself and combined with other influential data such as weather, noise, number of visitor and messages on social media (Ruijsink and Smith, 2016). This way, Stratumseind 2.0 refers to one single project. As mentioned before, the data gathered aims to create a comprehensive scenario about the street, combining real-time data captured by appliances installed in the street with information collected with delay. The results from this extensive data collection are openly and democratically accessible, available for anyone's appreciation through open source software (Eskelinen, Robles, et al., 2015, Snijders, 2016). The improvement of the safety, economic viability and attractiveness in the street helps to boost the prosperity of the area and to increase the well-being of the stakeholders and the inhabitants of the city in general, what can be considered outcomes that impacts in the sustainable urban development of Eindhoven. Also, the implementation of the ULL is a showcase of this kind of innovative project and can stimulate similar initiatives.

Activities

As well as The Green Village, the activities of co-creation, development of innovation, experimentation and learning and evaluation are present in Stratumseind 2.0. A more complete description of the actors and their roles can be found in the Table 23 of Annex III. Since the beginning of the ULL, actors from all the four groups of the Quadruple Helix were involved in the co-creation process, however with different levels of decision power. There is an exploration in the lighting research field, since it is the first time Philips is conducting experiments about use of light focusing the use of colours and its ability to influence mood and stress levels of visitors in the public areas of Stratumseind. Other technology producers are also interested in the possibilities of trying new instruments or new uses for existing technologies under real-life conditions in a public space. The project also offers an opportunity to explore in the field of data analysis because the amount and variety of data collected requires from data scientist new skills in order to combine patterns and create new insights (Den Ouden, Valkenburg, et al., 2014). To materialize the experimentation phase, interventions are done on the street: installation of appliances for instantaneous data collection; experimentation with new uses for the technology. The information collected in the street is combined with data from other sources. Correlating the data on incidents to specific parameters is a way to predict when there is a risk for escalation and then, if necessary, to ensure a fast intervention in the area avoiding dangerous incidents. This process is essential to create historical data from past incidents to be used to find such correlations. When reached a determined risk level, the lighting scenarios are activated, new data is produced and gathered again, and the effectiveness of the method can be subsequently analysed. This last step consists in the evaluation activity of the ULL.

Participants

Stratumseind 2.0 is a provider-driven ULL, since the network was formed around the provider organization, i.e. the Municipality of Eindhoven, who is also utilizing the project to achieve its goals and has the greater say in the initiative due to its large responsibility for any intervention in public areas involving real users. Other public-sector actors from regional and national government are also providers of funding and the companies add practical experience, knowledge and technology. The role played by Philips must be highlighted, considering its

importance, because the company is not only the provider of lighting technology, but it is also utilizing the project to experiment in a real-life setting. The enablers in Stratumseind 2.0 are organizations who bring expertise in safety issues (DITSS and CrimiNee!) or act as intermediary between other stakeholders (Polyground). The pub owners, residents and visitors play the role as users observed in their behaviour and they may offer knowledge and feedback. They also represent the largest group since between 10,000 and 15,000 people visit the street every week. Several knowledge institutions compose the group of researchers, mainly interested on experimenting using their own resources, followed by analysis of results and creation of new knowledge. The Infographic 2 provides an overview of the network arranged around Stratumseind 2.0 project.

Context

The Stratumseind Living Lab has been active since 2014, however the continuity of the project is uncertain after 2018. In comparison to The Green Village, Stratumseind 2.0 has better performance regarding its embeddedness in a geographical area because its activities take place in a real-life environment facing challenges in a daily basis: in a 250 meters long street, located in the inner-city area of Eindhoven, with around 50 pubs. The cameras and sensors are placed along the street (Figure 16).

Figure 16: Sensors and smart lighting installed in Stratumseind 2.0

Source: Author (2017)

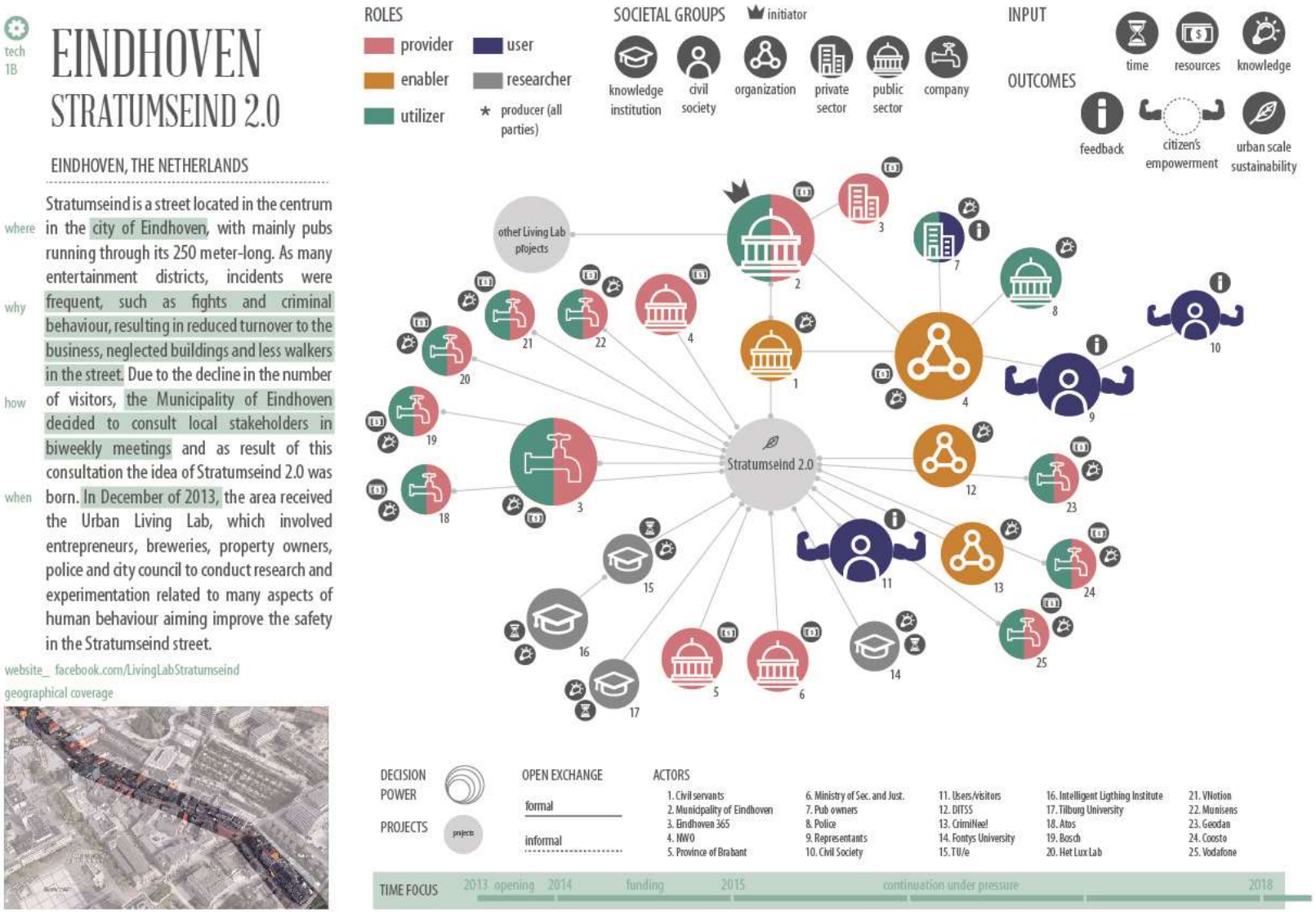
Concerning the role of the local government in the ULL, as explained before it is part of a bigger initiative named Eindhoven Living Lab. Having said that, the support offered by the Municipality has an official status and about 50% of the project is financed by the local government for diverse reasons: it directly contributes to make the street more viable; the project fits in the political agenda for security and safety and it can also be used to promote the image of Eindhoven as Smarty City. Once the data is openly available, residents and visitors can use that to monitor the activities happening in the street, giving them the knowledge and tools to ask for improvement if necessary. In this case, the citizens are more empowered and can better address their needs.

Why is Stratumseind 2.0 a technology-driven ULL?

Stratumseind 2.0 is an Urban Living Lab because its multistakeholder approach; real-life setting applied in an urban space; its aim to deliver urban innovation and experimental

character. Because Stratumseind 2.0 is an area of the city where it is possible to experiment with new uses for existing technologies, involving real users who are observed and provide feedback, generating new knowledge and resulting in an improved post- intervention scenario, it can be labelled as *technology-driven* ULL.

Infographic 2: Eindhoven Stratumseind 2.0

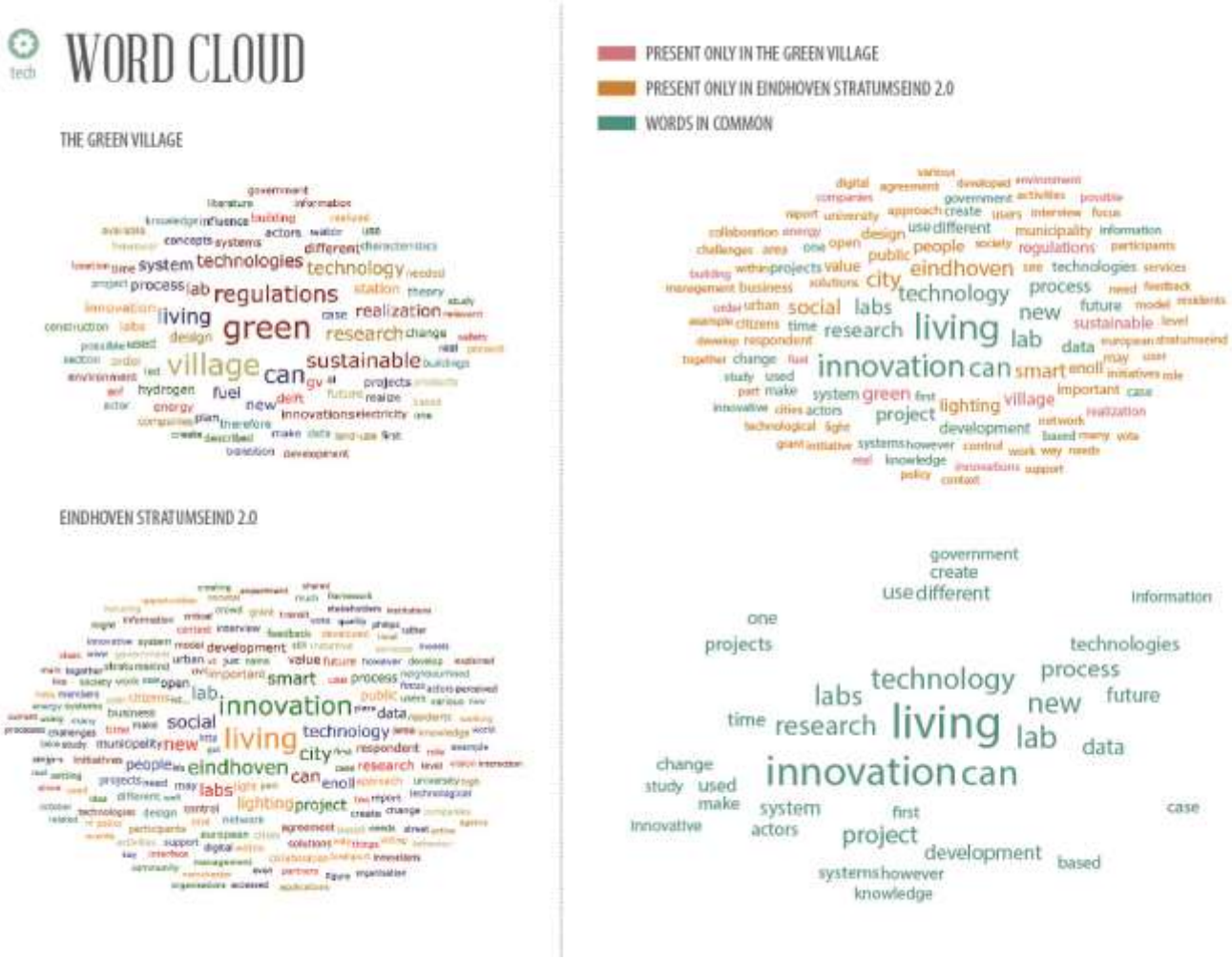


Source: Author (2017)

5.2.3 Comparison between the cases

As presented in Table 7, the keywords commonly found in the literature about *technology-driven* Urban Living were: *smart city*; *smart citizen* and *technological solution*, or other similar terms. Three world clouds were generated on Atlas.ti to compare keywords from empirical studies with keywords from the theory. The frequency of appearance of a word ranges from 1 (at least one appearance) to the number of appearances of the most used word. Only words with a frequency of 10% or more of the number of appearances of the most cited word were include in the clouds. The first cloud refers to The Green Village, created with words that appear at least 40 times (10% of 407). The second cloud refers to Eindhoven Stratumseind 2.0 generated using words that appear at least 92 times (10% of 923). The third one combines terms from the two cases that appear at least 115 times (10% of the range between 1 and 1149 available on Atlas.ti). The words with a large number of appearances in both clouds were highlighted in blue in order to understand which keywords are more present in the literature from both cases. The following result was obtained when combining both word clouds (Figure 17):

Figure 17: Word cloud technology-driven ULL



Source: Author (2017)

Among 35 most frequent words that appear in the literature of both cases, only technology and technologies are related to the previous selected keywords, being smart city and smart citizen not mentioned as often as expected. However, terms such as innovation, innovative, new, use,

different, create, future, change, make, development and first show how essential is for the cases to deliver innovation by creating novel products, services or new uses for existing ones. Words like information, research, data, study and knowledge are indicatives of the strong role of the knowledge institutions in the cases and the importance of activities of evaluation and learning. However, contrary to expectations, university does not appear in the list of words, but the presence of government and actors indicates the multistakeholder approach and active presence of the public sector in both initiatives, either as utilizers or as provider. The remaining words projects, process, time, used, system, project, based, case and systems are related to the methodology and activities adopted inside the ULL ecosystem. The words living, lab and labs refer to the label Living Lab, however urban does not follow them what can mean that geographical embeddedness in an urban area, urban challenge or urban sustainability are not the main focus in the projects. Another interesting consideration regards the presence of the name of the city where the projects are located. Eindhoven was more cited in the database about Stratumseind 2.0 than Delft was mentioned in the literature about The Green Village, which underlines the difference in the importance of the place itself for each case. The following Table 12 presents the count of the words common for both cases:

Table 12: Word count in the Technology-driven ULL literature

Group	Word	Number of appearances
Technology	technology	591
	technologies	275
Innovation	innovation	942
	new	596
	development	289
	future	263
	different	262
	use	231
	change	197
	make	181
	create	180
	first	137
	innovative	123
Evaluation and Learning	research	479
	data	345
	knowledge	171
	study	144
	information	140
Participants	actors	183
	government	158
Methodology	project	409
	process	376
	system	252
	projects	239
	time	225
	used	188
	systems	179
	based	170
	case	162
Living Lab	living	1149
	lab	632
	labs	526
Others	can	749

	one	203
	however	175

Source: Author (2017)

Subsequently, some other conclusions on the main characteristics of technology-driven ULL that could be drawn comparing the two selected cases are presented.

Goal

As previously indicated, the main goal in an Urban Living Lab is to deliver innovation, such as new knowledge, products or services, oriented to urban challenges. The process to delivery of innovation must be as open as possible, i.e. the knowledge comes not only from inside the organization but also from outside partners. In The Green Village there is development and implementation of sustainable technological innovation oriented to urban challenges, however it happens in a test-bed site, involving inside and outside partners in an open process of knowledge development and exchange. In the other case, Stratumseind 2.0 enabled experimentation with novel technologies applied in a real urban setting. In this way, there is more emphasis in new uses for existing technologies, especially their feasibility when utilized in urban public spaces. Therefore, the cases seemingly to occupy different positions in the innovation development process. The Green Village is positioned a step earlier in the innovation development chain in comparison to Stratumseind 2.0, since the technological appliances could have been tested in the GV before being installed in the street.

Although TU Delft does not clearly state that, The Green Village project can be used to promote and attract investments for the institution and to leverage the innovation, especially important for technology universities. In the other case, the local government is explicitly using Stratumseind 2.0 and other Living Labs to brand Eindhoven as Smart City. This publicity brought to the initiators by the projects can also be one of the goals of this type of ULL, once the technological approach requires a constant search for new investments. In conclusion, the main goals of technology-driven ULL are improvement of technology; development of new products; services and/or uses; and branding strategy and attraction of investments, being the innovative outcomes allies in the pursuit of urban sustainability.

Activities

Regarding the activities performed in the technology-driven ULL, there are some findings to be highlighted. About the activity of co-creation, all the actors participate, however with diffuse roles, which means the same actor can play more than one role. Both Urban Living Labs are provider-driven, i.e. the network is formed around the provider organizations: TU Delft and Municipality of Eindhoven. Based on the literature review, in this type of Living Lab the information is collected for immediate or postponed use and the new knowledge is based on the information that provider gets from the others (Leminen, Westerlund, et al., 2012). This characteristic is present in both cases: in The Green Village, the knowledge comes from other actors, such as users, companies and researchers and the information is collected for postponed use to improve the development of technology. Differently, in Stratumseind 2.0 the information gathered through sensors and cameras results in immediate intervention, using the dynamic lighting in response to what is happening in the street at that moment.

The methodology applied in the type of ULL resembles the experiment research strategy: an experiment based on a research (knowledge produced inside or outside the ULL ecosystem) happening in a real-life setting, where is possible to observe its operation in practice, and the actions and behaviours of the users when interacting with it are monitored and new knowledge is produced by reviewing the data collected. To summarize, the activities in a technology-

driven ULL follow a systematic planning cycle, which allows the process to be repeated as many times as necessary to achieve the goal.

Participants

Actors from the four groups of the Quadruple Helix (public sector, private sector, knowledge institution and citizens) are present in both The Green Village and Stratumseind 2.0. However, there is a substantial difference in the number of actors involved per group when comparing the cases. While in The Green Village between 100 to 120 companies and organizations participate, in contrast Stratumseind 2.0 has more than 20 partners. This can be explained by the number and variety of projects taking place in the Delft's test-bed, what facilitates the involvement of more actors and give them more flexibility to experiment since they are located in a place that was designed for that. The real-life feature of the Urban Living Lab implemented in Eindhoven is a limiting factor for inclusion of more actors, especially because the intervention must be closely controlled by the Municipality, who is responsible for any intervention in a public space and does it interfere in the users' life.

About the citizens, they are fundamental to the development of the projects in both cases, but their role is user and they are source of information when observed during the usage of technology and space. With this in mind, it is right to assume that the initiator, who is also the main provider, has the bigger stake in a technology-driven ULL and the number of participants from other societal groups depends on the existing infrastructure (new or adapted) to receive the interventions and the number of projects simultaneously being developed.

Context

The geographical coverage in a technology-driven ULL vary from a test-bed to an area within the city as long as they are linked to real-life setting. In The Green Village, the real-life linkage is ensured by users and companies, who are experimenting with real cases. However, since the Eindhoven ULL is implemented in a public area, it receives more visitors and brings closer the citizens. In addition, there are residents living inside the area where Stratumseind 2.0 is located, while the only residents in the GV so far are students living in two experimental housing. The area where the experimentation happens has very well demarcated boundaries for two reasons: first because of the limitation in funding and technology to cover large geographical area and in second the use of technology and its impact must be under strict control, which requires its application within clear spatial limits.

The role played by the Municipality is an important difference between the cases. In both cases it is a utilizer, meaning the local government uses the ULLs to improve its planning system by testing new participatory processes or to intervene in a specific area of the city and gain with its upgrades. This way, both the Municipality of Delft and Eindhoven act as enablers because they loosened regulations to make easier the innovation process inside the ULL ecosystem. Concerning the other roles played by the local government, the Municipality of Eindhoven is also the initiator and main provider for Stratumseind 2.0, for reasons above discussed. About the times focus, this is an aspect not easily compared, because even The Green Village is a temporary site with expected duration between five and ten years, it consists in several projects with different timeframes, while Stratumseind 2.0 is a four-years single project. What can be concluded from the findings is that the technology-driven ULL has a temporary character, i.e. there is no intention to make permanent the interventions, what is reasonable given how fast technological development occurs today. The local government is a close actor, playing different roles as provider, utilizer and/or enabler, especially regarding regulatory aspects.

What is a technology-driven ULL?

The following Table 13 shows the main characteristics of the two cases and how they were combined to portray this type of Urban Living Lab.

Table 13: Technology-driven ULL cases and characteristics

Variables	Characteristics	The Green Village (NL)	Stratumseind 2.0 (NL)	Summary and conclusion
Profile	*Initiator*	• Knowledge institution (provider)	• Public sector (provider)	• Initiators are also the main providers.
Goal	*Urban Innovation*	• Development and implementation of sustainable technology in a test-bed; • Boosting of innovation on TU Delft.	• Experimentation with technology in an urban area; • Branding of Eindhoven as Smart City.	• Development of new knowledge and products with strong technological approach; • The network can use it as a branding opportunity.
	Open knowledge development and innovation for application	• Open exchange between inside and outside partners	• Production of data openly and democratically accessible	• Open exchange of the technological innovation.
	Local sustainability innovations	• Development of new sustainable technologies	• Improvement of urban safety and citizens' wellbeing	• Projects are allies in the pursuit of urban sustainability by improving technologies.
Activities	*Co-creation*	• Provider-driven; • Diffuse roles.	• Provider-driven; • Diffuse roles.	• Provider-driven; • Diffuse roles.
	Development of Innovation (exploration)	• Products and/or services;	• Uses and/or processes;	• Development of new products, services, uses and/or processes.
	Experimentation and Learning	• Research program; • Physical demonstration.	• Intervention; • Data collection and learning.	• Systematic and monitored planning cycle to guide experimentation.
	Interaction between activities of evaluation and learning	• Feedback collection and postponed use.	• Feedback collection and immediate and postponed use.	• The data is collected during users' interaction with technology/space and is used to further develop the products.
Participants	*Users, private actors, public actors and knowledge institutes*	• Quadruple Helix actors; • Between 100 to 120 companies and organizations.	• Quadruple Helix actors; • More than 20 partners.	• Quadruple Helix actors are active contributors; • The number of participants depend on the number of projects carried out in the ULL and their features.

Variables	Characteristics	The Green Village (NL)	Stratumseind 2.0 (NL)	Summary and conclusion
	User centred	• Users are observed, and they provide feedback.	• Users are observed.	• Users are observed in their interaction with products/spaces, however they are less active as producers; • The users can be either a person interested in the project or an independent visitor using the space.
	Decision power	• Different levels of decision power.	• Different levels of decision power.	• Initiator (and main provider) has the bigger stake; • All participants share a certain level of responsibility and decision power.
Context	*Geographical Coverage*	• Test-bed located in the campus	• Public space of one street	• The geographical coverage has very well demarcated boundaries.
	Real-life Setting	• Site with real-life features where real cases are tested.	• Urban challenge with direct negative impact on citizen's wellbeing.	• Enacted in a real-life context that varies from a lab setting to a public space.
	Part of an Ecosystem	• Local Government is utilizer and enabler.	• Local Government is provider, utilizer and enabler.	• Part of the formal planning system covering smaller units of a city; • Close involvement of the local government softening regulatory aspects.
	Time Focus	• Temporary (5-10 years).	• Temporary (4 years).	• Short or long-term actions, with temporary character.

Source: Author (2017)

When comparing the findings about technology-driven ULL with the characteristics of Urban Living Lab based on the theory (Table 5), some important concluding remarks should be make. First observation regards the local sustainability innovation topic: while Stratumseind 2.0 is supporting local solutions focusing on promoting sustainable development, in accordance with the theory, most of the innovations developed in The Green Village are not designed targeting a specific place, but aiming an overall improvement in the current technologies being used in buildings and cities. The times focus of a technology-driven ULL should also be remarked since it has no intention to promote permanent changes in the urban environment itself, however the knowledge acquired in the project can be later used to this end. The greater resemblance of technology-driven ULL to the broad definition of Urban Living Labs (Box 2) regards the organized approach label, because both technology-driven cases were implemented following a clear operational plan.

5.3 Transition-driven

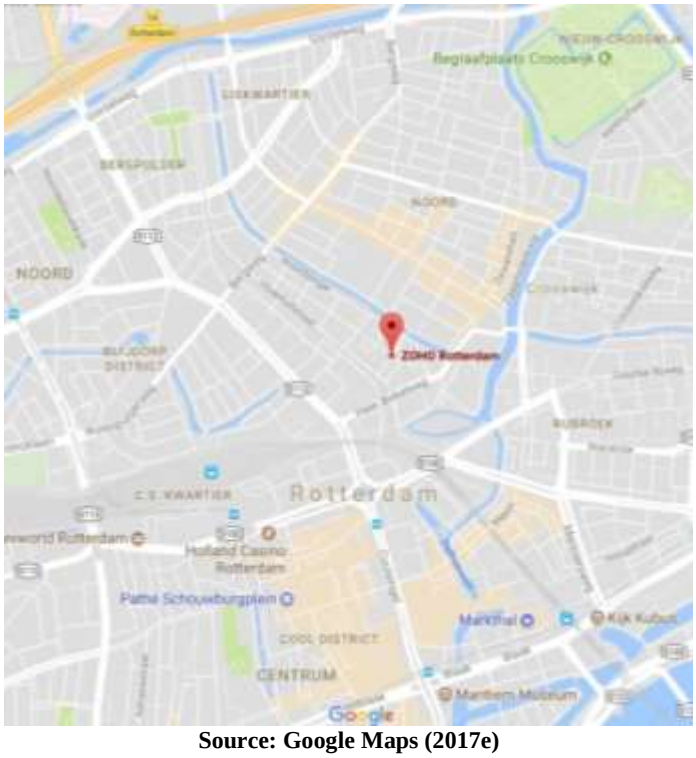
This type of Urban Living Lab has a dual approach to deliver transition towards sustainable urban development. It can act as *an arena for deliberation and a space for self-organizing groups* or *a tool to enable urban experimentation*. The first one works implementing a new local governance model, reaching self-organizing groups, normally detached from formal urban planning. The second one is situated in in the boundaries between research, innovation and policy. In this way, this type of Urban Living Lab differs from other urban innovation methods because of its place-explicit urban focus and experimental feature towards solutions and/or approaches to better address current sustainability issues. ZOHO and Living Lab Circular Buiksloterham are both examples situated in The Netherlands that fit in the second group of transition-driven ULL. ZOHO is an area situated on the edge of the inner city of Rotterdam and since 2013 is under development following a strategy of slow urbanism (STIPO, 2017). Living Lab Circular Buiksloterham is situated in an industrial area of Amsterdam where bottom-up experiments, research, culture and innovation are encouraged aiming to develop a sustainable community (Steen and Van Bueren, 2017).

5.3.1 ZOHO (NL)

Figure 18: Logo ZOHO

Source: STIPO (n.d)

Figure 19: Location ZOHO



Source: Google Maps (2017e)

Figure 20: ZOHO building at Zomerhofstraat

Source: Author (2017)

ZOHO (Figure 22) is the first case of transition-driven ULL to be analysed. The initiative is located in a former business district of Rotterdam called *Zomerhofkwartier* (Figure 19). In 2006, the housing corporation Havensteder bought a few deteriorated office buildings, situated in the edge of the city centre, with an idea to demolish and replace them for housing. However, a national crisis puts a stop in the area development until 2013, when Havensteder, with the collaboration of STIPO, replaced the initial masterplan for a new approach: a 10-year long development plan with high ambition for a vibrant and innovative urban area. They are also interested to learn about new ways of urban development. Because of that, they decided for

experimental development process named *slow urbanism* and since then, the vacant buildings have been filled up (Figure 20), ground floors have been opened to bring new uses for the public areas and to create a new cultural extension of the city centre (Snoek, L., 2015). ZOHO was visited on 8th November of 2017, to observe the buildings that make part of the initiative and the interventions in the surrounding area. A 57 minutes long interview was conducted with a member of the ZOHOCitizens, a collective of entrepreneurs, residents and stakeholders in ZOHO.

Goal

The main goal of ZOHO as ULL is to transform a stagnated area close to the centre of Rotterdam into a vibrant neighbourhood. To achieve this, ZOHO innovates and recreates new local and global networks by recruiting and selecting new entrepreneurs to work together in an urban laboratory where promising climate measures combining urban transition and local initiatives (De Urbanisten, 2017, Lofvers and Devos, 2015). The "slow urbanism" development approach is the key innovative outcome of ZOHO, since it implies novel urban development planning and networking. Since 2013, the initiator Havensteder invited STIPO as partner and together they decided to test this development model for ten years. Havensteder started to rethink and allowed small experiments. The change of approach is explained by the feasibility of implementation of slow urbanism masterplan even during the national crisis due to its gradual character (re:Kreators, 2017). There are strong partners in and around the area: all businesses located in the area and surroundings are considered potential partners to stablish a network and exchanging of knowledge. For instance, in the area are located companies and education institutions. What guides the selection of new partners or projects to be developed inside ZOHO ecosystem is the possibility of value creation, not only to the private sectors but especially to the residents of the area, who are invited to join the initiatives. The outcomes of this approach are creation of new business and consequently increased employment rates and a more vibrant and safe area, with alive public spaces, since the actors are investing also in the outdoor areas. Since the projects being developed inside the ULL are closely related to the Rotterdam Adaptation Strategy, ZOHO works as test site for rainproof public spaces and climate proofing strategies, such as green rooftops and less paved areas. Therefore, it is right to assume that the ULL is supporting the city to transition for a more sustainable and resilient future.

Activities

About the co-creation activity happening in ZOHO, all actors participate as producers, however in different levels. As same as the technology-driven cases, also in ZOHO the roles performed by the actors are diffuse. For instance, the initiator, Havensteder, is not only the main provider, since it is the major landlord in the area, but its main role is enabler, because of its initiative to allow a different path of development in its properties.

The exploration happening in the ULL regards different scale of intervention, such as property (the buildings), neighbourhood (Zomerhofkwartier and surroundings) and city (projects part of Rotterdam Adaptation Plan such as *Benthemplein* water plaza). New ways of thinking and doing are also explored, by including existing institutes and practices. In doing that the ULL works as a showcase for the partners and as a place to experiment, even with new business models. The process adopted in the experimentation phase is based on three integrated premises: connect, create and learn. To connect by selecting new tenants for the building through pitches, attracting actors who agree with the principles that guides ZOHO's development; by including existing partners in the area to create a network around the ULL; and by attracting new visitors. To create new business models, places, activities and services, by taking advantage of the variety of uses and partners' expertise within the network. To learn

with practical experience acquired in projects from inside and outside the ULL ecosystem. The evaluation and learning activity in the case of ZOHO happens by trial and error, due to its experimental character:

> *"[…] our lessons that we learned from the crisis that if you want to redevelop, especially with all the chances it gives you should do it, let's say. in an innovative and interesting way and to aim for a high level of redevelopment. So, it should be truly cooperative in our meaning and should not be the standard answer that a normal developer would give to a housing area. So, what it should be then?"* (ZH Expert, 2017)

Participants

The main contribution of the initiator Havensteder is as enabler because of its willingness to experiment and bring in together other partners with the same interests, what is essential for the ULL viability, even though the company also plays roles as provider and utilizer. The Municipality of Rotterdam is enabling the ULL when it applies more lighten laws and regulations, but it is also providing funds and utilizing the initiative to learn practical experience about regulations and projects. Other enablers, who bring tools, knowledge and/or methods for research, are STIPO, ZOHOCitizens and the Ministry of the Interior and Kingdom Relations. Besides the Municipality, other providers are the tenants of the buildings, who are investing their money in the renovation of spaces, including outdoor areas when they occupy the ground floor; and the European Commission, who is funding the construction of the rain garden through the European Union's LIFE funding programme.

Companies and entrepreneurs are the main utilizers in the ULL, using the network built inside ZOHO as a solid basis to invest their time and money in order to enhance their innovative projects. The users are visitors and residents since they are part of the interventions. For instance, residents participated in the transformation of a vacant plot into a green area (Figure 21), given them a sense of ownership over the space.

Figure 21: Green public space in Schoterbosstraat

Source: Author (2017)

There is no knowledge institution formally working together with ZOHO, playing a role as utilizer, provider or enabler (different of technology-driven ULL cases). However, students and STIPO use ZOHO as a case to be studied to learn from its experience. Since what determines

the main role of an actor is the impact it causes in the network, it is possible to classify ZOHO as enabler-driven, i.e. the network forms around a region (Zomerhofkwartier district) or a funded project (e.g. public funding for the Adaptation Plan) (Leminen, Westerlund, et al., 2012). More detailed information on integration of actors and projects can be found in the Infographic 3.

Context

The ULL takes place in the former business area named *Zomerhofkwartier*, near the train station Rotterdam Centraal and the inner-city centre, sandwiched between Bokelweg, the Hofbogen, the Teilingerstraat and the Noordsingel. It covers five hectares of indoor areas, with 25,000m² of floor surface, distributed in four buildings (*Het Gebouw*, *Het Gele Gebouw*, *Katshoek* and *Hofbogen*), and outdoor areas (green, seating areas, lighting, streets, skirting boards, and public facades). Entrepreneurs are renting offices in the buildings and also intervening in the public areas, with the active participation of residents of surroundings.

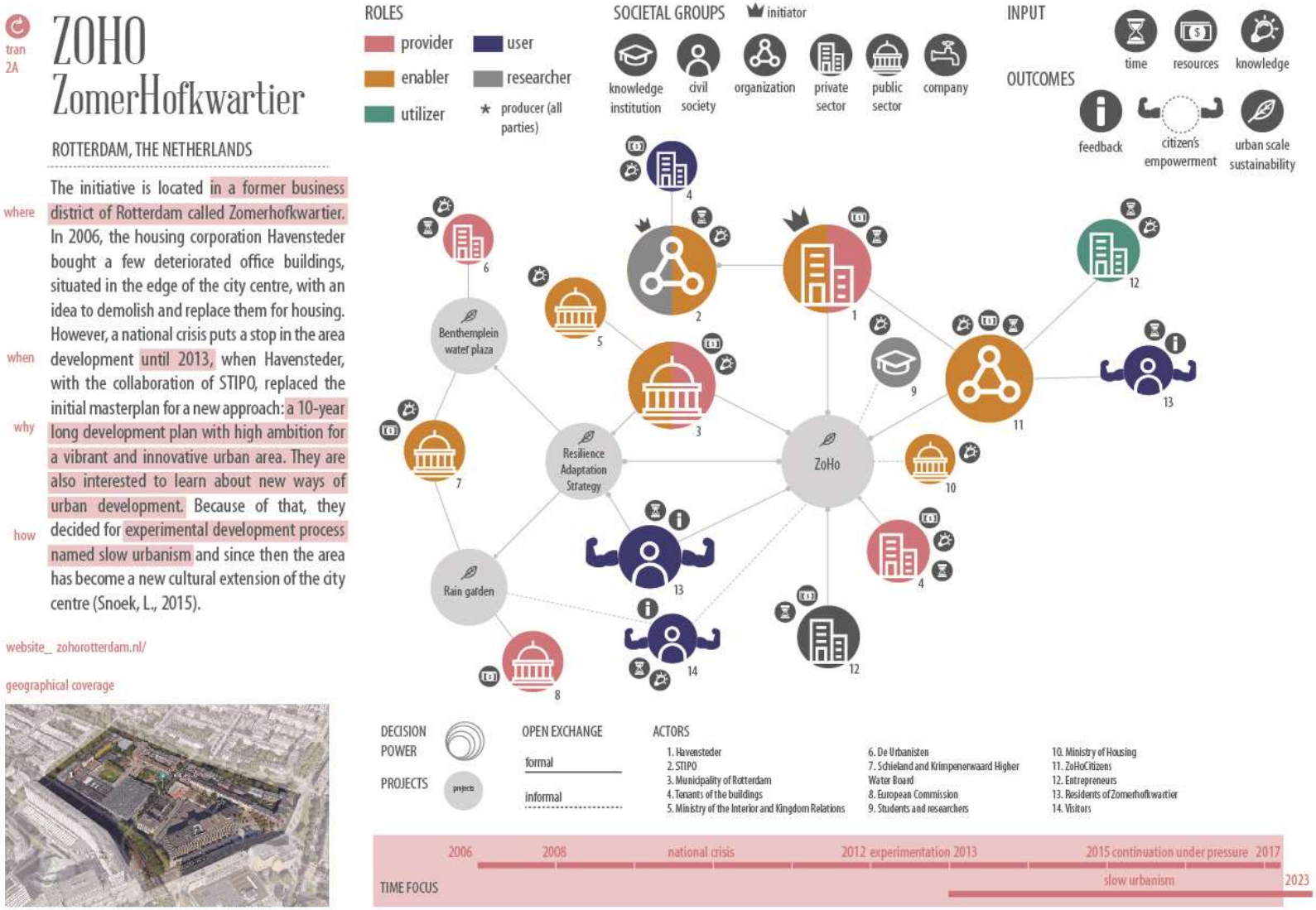
Concerning the role of the local government in the ULL, ZOHO is part of a target area for the Municipality of Rotterdam due to its climate vulnerability, facing the threat of flooding. This issue is addressed in the municipal climate change resilience plan, released in 2003, which guided the construction of project such as Benthemplein water plaza, rain garden, underground infiltration system under Ammersooiplein and depaving strategy, i.e. increase in green areas and reduction of areas with pavement. All these projects have a close relationship with the activities performed by ZOHO, transforming the initiative in a relevant partner for the achievement of the Municipality's goals for resilience and environmental improvement. This way the local government is more willing to support the interventions by funding and flexibilization of regulations.

The impact of ZOHO in how citizens can better address their needs occurs in two scales: neighbourhood and city scale. In the neighbourhood level there is an improvement in safety, vibrancy and quality of the public areas, especially because the diversity of newly open business and the community-led interventions. Social enterprises and the neighbourhood coop to involve residents and bring people from a situation of unemployment to a day structure and eventually jobs. Residents and students, coordinated by the urban planners, designed the climate-adaptive "rain garden" built along the Hofplein line, a project that impacts in a bigger scale than the neighbourhood. Regarding the time focus, ZOHO adopts the "slow urbanism" strategy meaning a 10-year long development, from 2013 to 2023. In the meantime, there is room is room for trying, from long rental periods to temporary events.

Why is ZOHO a transition-driven ULL?

As defined in the Table 7, a transition-driven ULL is an ecosystem that connects different stakeholders focused on enhancing the transition towards sustainability by promoting urban experimentation. ZOHO fits in the two aspects of this description: it is an environment where a network is being constructed with stakeholders who share the interest to promote urban experimentation aiming the transformation of a stagnated area of Rotterdam into a vibrant neighbourhood.

Infographic 3: ZOHO



Source: Author (2017)

5.3.2 Living Lab Circular Buiksloterham (NL)

Buiksloterham (Figure 22) is a brown-field area of Amsterdam, where heavy industries previously located there moved out and left behind some areas with polluted soil. Located in the Northern bank of the River IJ, just five minutes ferry trip distant from the old centre of the city (Figure 23), the area was left underdeveloped for a long time, until 2006 when the city council concluded it was time to redevelop the district (Reimerink, L., 2016, Savini and Dembski, 2016). However, due to funding constraints during the financial crisis between 2007 and 2009, there was no large investments to implement the redevelopment, an issue solved by the Municipality by encouraging bottom-up experiments, research, culture and innovation (Steen and Van Bueren, 2017). Since empty plots are available and there was almost no monumental buildings because the former activities carried out in Buiksloterham, it creates space and flexibility for an organic transformation project: the industrial area was translated into a mixed use urban area with high ambitions regarding circular economy (Gladek, Van Odijk, et al., 2015, Prendeville, Cherim, et al., 2017). One example of experimental initiative part of the development of Buiksloterham is a fully circular community named *De Ceuvel* (Figure 24), a living lab started in 2010 when a tender was promoted by the Municipality has as target a polluted industrial site. The winner project, designed by Space & Matter and DELVA Landscape Architects, addressed the contamination by developing a soil cleaning and nutrient-filtering landscape featuring retrofitted houseboats used as offices, ateliers and workshops (Lokman, 2017, Prendeville, Cherim, et al., 2017, Steen and Van Bueren, 2017).

The author visited the area on 26th October 2017, between 11:00 and 14:00 in the afternoon. The visit was focused on Cafe De Ceuvel and the activities settled in the site (covered by the vegetation to clean up the area) were observed. Another visit was on 07th November 2017 at 11:00h when the author conducted an interview (50 minutes of duration), with one member of Metabolic, one of the actors in Living Lab Circular Buiksloterham.

Figure 22: Logo Living Lab Circular Buiksloterham

Source: Buiksloterham (n.d.)

Figure 23: Location Living Lab Circular Buiksloterham with Cafe de Ceuvel marked

Source: Google Maps (2017a) with modification by author (2017)

Figure 24: Cafe De Ceuvel in Buiksloterham

Source: Author (2017)

Goal

The main goal of Circular Buiksloterham is to transform the former brown-field site into a sustainable and circular district, combining industrial location with other uses, such as housing and offices, making use of a participatory process involving citizens, entrepreneurs, knowledge institutions, city government and other public organizations. The transition from industrial use to a mix of functions requires several projects with different approaches, ranging from integrated small projects and innovations (*De Ceuvel*) to big pieces of land to be redeveloped (*Schoonschip*, *CityPlot* and *Self Builders*). For the small-scale projects, a smart selection must be done due to limited means, time, money and capabilities to implement them in practice. The circular ambition above mentioned is linked to five themes, according to the Municipality of Amsterdam (Amsterdam Smart City, 2016a): energy-neutral construction; raw materials; construction procedure; climate adaptation and sustainable mobility.

As outcome of the Circular Buiksloterham initiative, new knowledge is produced regarding better regulations for new-build homes and circular economy and a more efficient use of resources, such as water, energy and recycling materials is developed. Even though an open exchange of knowledge can be mentioned as one of the goals of Circular Buiksloterham, there is a focus in a local exchange instead of large networks. CityLab Buiksloterham is the organization responsible to enhance the communication between different parties by organising table sessions related to different themes, like energy, water and waste. Professional workshops in the field of culture, organizational development and design and sustainability at De Ceuvel is a way to exchange knowledge and lessons learned with the outside community. On the other hand, subsidies, loans and donations are the contribution of the external community, a crucial input for the feasibility of some initiatives.

The contribution of Buiksloterham as Living Lab to the sustainable urban development is the shift from a linear production system, in which resources, goods and waste products are exchanged across the globe (Delva, Wijnakker, et al., 2016), into a more circular system by mixing the uses in the urban area, by implementing integrated sustainable techniques such as renewable power, rainwater harvesting and recycling and by developing new models for production, consumption, distribution and logistics (Amsterdam Smart City, 2016a)

Activities

As same as ZOHO, the co-creation activity in Buiksloterham consists in different levels of involvement of all actors as producers, meaning they contribute for the innovation development. These partners can also perform other roles, depending on the kind of resources they bring or how they appreciate the outcomes of the projects. In Buiksloterham, topics like interactive governance, working with legal constraints and zoning plan, sustainable techniques and circularity are the targets of the exploration activity. The planning cycle from idea to product, adopted especially by De Ceuvel, starts from practice by trying out, involving various actors and developing solutions that truly work:

> *"[…] this land was heavily polluted because of the chemicals they used during their own process of ship building, and during credit crisis, financial crisis, the municipality did not have any money to revitalize the soil, get the funding, get the sewage system in and then start to build. But they already had their plans of building like large boulevards streets here and getting… earning a lot of profit, from all of offices, buildings and living spaces, etc. So a group of architects of Space & Matter, DELVA and Studioninedots, they came together and they came with the plan of revitalize all the houseboats and making them fully self-sustainable because if you make them fully self-sustaining you can place them on the land and you do not need to dig in the polluted soil and DELVA landscape architect pick the right type of plants and these plants are now cleaning the soil through a process called filtered mediation so this is all small*

experiments happening in this area to test and show case sustainable technologies." (CB Expert, 2017)

In general, the experimentation process carried out in Buiksloterham is characterized for being more organic and collaborative. For instance, several plots in the district are reserved for individual private development. To make it possible the Municipality of Amsterdam made changes in the current zoning and regulations, step followed by the allocation of plots and selection of candidates. Meetups between developers and future residents are a tool to stimulate both social contacts and knowledge exchange in terms of circular building. About the evaluation activity, there is an intention to use the ULL to assess the impact of innovations on residents and external safety before the technologies can be used in other neighbourhoods. However, the implementation of monitoring system is not universal for all the projects in Buiksloterham. While a monitoring and measuring system analyses the different flows of energy and materials in De Ceuvel (Figure 25), at the same time it is difficult to evaluate specific sustainability performances in the self-construction site since there is currently no coherent monitoring plan and hardly anyone is already living on the plots (Delva, Wijnakker, et al., 2016).

Figure 25: Board explaining the monitoring system installed in De Ceuvel by Metabolic

Source: Author (2017)

Participants

The Municipality of Amsterdam was the initiator, when the city council decided to redevelop the district in 2006, and main enabler, facilitating and supporting the development of the neighbourhood, in an experimental way. However, as the Municipality has a budget to finance sustainable projects and to invest in restructuring projects targeting infrastructure and public spaces, it plays a role as provider. Most of the actors participate as enabler: Ceuvel Association, Metabolic, Studioninedots and DELVA Landscape Architectures, CityLab Buiksloterham, Waterloft, Space&Matter, Schoonschip Foundation and volunteers and professionals. The tools, knowledge and methods for research the enablers bring to Buiksloterham are essential to create a stimulating environment for experimentation. Other providers are tenants, self-builders and entrepreneurs. These actors are part of the civil society and still they provide a substantial funding. This is part of the local government strategy to overcome the credit crisis of 2008

sharing the costs of the Buiksloterham development. Municipality of Amsterdam, companies and entrepreneurs are the main utilizers, each of them taking advantage of the ULL to boost their own purposes. The users are not only visitors and residents, like in ZOHO, but also the self-builders. The Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute) with four other knowledge institutions, will work together in the ULL, along with the business community and local residents, to develop innovative solutions and to produce knowledge about circular economy (AMS Institute, 2015).

In 2013, around 250 people were living in Buiksloterham. If fully occupied the self-constructions plots, the CityPlot and the Schoonschip, it is expected the number of residents increase to more than 6.400. The more active participation of citizens in Buiksloterham consist in the construction of self-build homes, when they can enjoy much more freedom than in the formal housing market regarding design decisions. Since Schoonschip is a Collective Commissioning Housing (CPO)[13], the future inhabitants are closely involved in since the initial steps. Other way to allow the active involvement of citizens in the projects is through volunteering offers for the construction process, from small projects developed in De Ceuvel to the Schoonschip big-scale project, what also contributes to strengthen the local community of Buiksloterham (Delva, Wijnakker, et al., 2016).

The Manifesto Buiksloterham is an example of how decision power is divided in the ULL. De Alliantie housing corporation and Waternet, a water company of Amsterdam, commissioned an extensive research to be conducted by Metabolic, DELVA Landscape Architects, Studioninedots and several individual professionals. The focus of the research was to integrate separated agendas of the stakeholders into a vision of Buiksloterham as a circular district, having as central point collaboration, integration and high sustainability ambitions. In 2015, 24 parties involved in Buiksloterham, including knowledge institutions, public sector, housing corporations, residents and companies, signed a Manifesto to endorse this ambition (AMS Institute, 2015, Geemente Amsterdam, n.d., Steen and Van Bueren, 2017). However, it was mentioned in the interview, the document represents a symbolic agreement:

> *"The powers are horizontally divided but when they signed the agreement they did not legally signed anything, so it is more of a symbolic agreement that they made than actually a signing an agreement like 'Okay, we are an Urban Living Lab'. So, all these different actors are using the momentum to experiment and try out new types of construction for housing, for instance, new types of sewage systems, to see what works and what does not work. […] So, like who spends the money where it is all being like an issue, so nobody wants to say 'Okay, I'm going to put all my money and they are just experimenting', they* [businesses] *are still busy with strategy, they are still busy with being competitive. so, in a sense signing the agreement, coming together and creating a vision for Metabolic's part did help in getting those actors together, talking more with each other than actually that they all agreeing with a certain amount of money they will expend on experimenting. But it is really interesting because a lot of different projects that we are running on a small scale here at De Ceuvel."* (CB Expert, 2017)

[13] Collective Commissioning Housing involves one or more private individuals acquiring land and deciding themselves which parties to commission for the design and construction of homes for their own use. The prospective resident does not appear at the end of the line as a costumer, but at the beginning as the commissioning party (Netherlands Institute for Spatial Research apud Knoester, Miazzo, et al., 2014, p 50).

Context

Buiksloterham is 100 hectares (net area consists of 52ha) district in the Northern bank of IJ River, known to be the most polluted industrial site of Amsterdam. With some remaining active industrial activity, the area is located just a short ferry from the city centre. Circular Buiksloterham covers 4 different intervention sites: 1. De Ceuvel, with 25 businesses in 16 houseboats located in a site with 0.45ha; 2. Schoonschip, with 46 residences in 30 boats, occupying an area of 0.85ha; 3. Self-build houses, composed by approximately 66 plots in 2.3ha; and 4. CityPlot, a mixed-use area including living, business space and catering sector, covering 2.8ha. Since 2006, the area is part of the municipal formal urban development planning (*Investeringsbesluit Buiksloterham: Transformatie naar stedelijk wonen en werken*). The total in investments required to develop the area was €157 million, €141 million of which was income form the ground lease. The municipality not only provides funding. In addition, it makes use of several instruments to contribute to the implementation of the Buiksloterham as a circular and sustainable district, such as tenders, land allocation and selection of self-builders, design of rules of development and zoning plan, provision of free guidance and intervention in the public space.

The citizens can better address their needs in the context of Circular Buiksloterham taking advantage of more relaxed regulations to experiment with new forms of housing development (CityPlot, Schoonschip and Self-Build) or with small innovation projects at De Ceuvel, as explained in the interview:

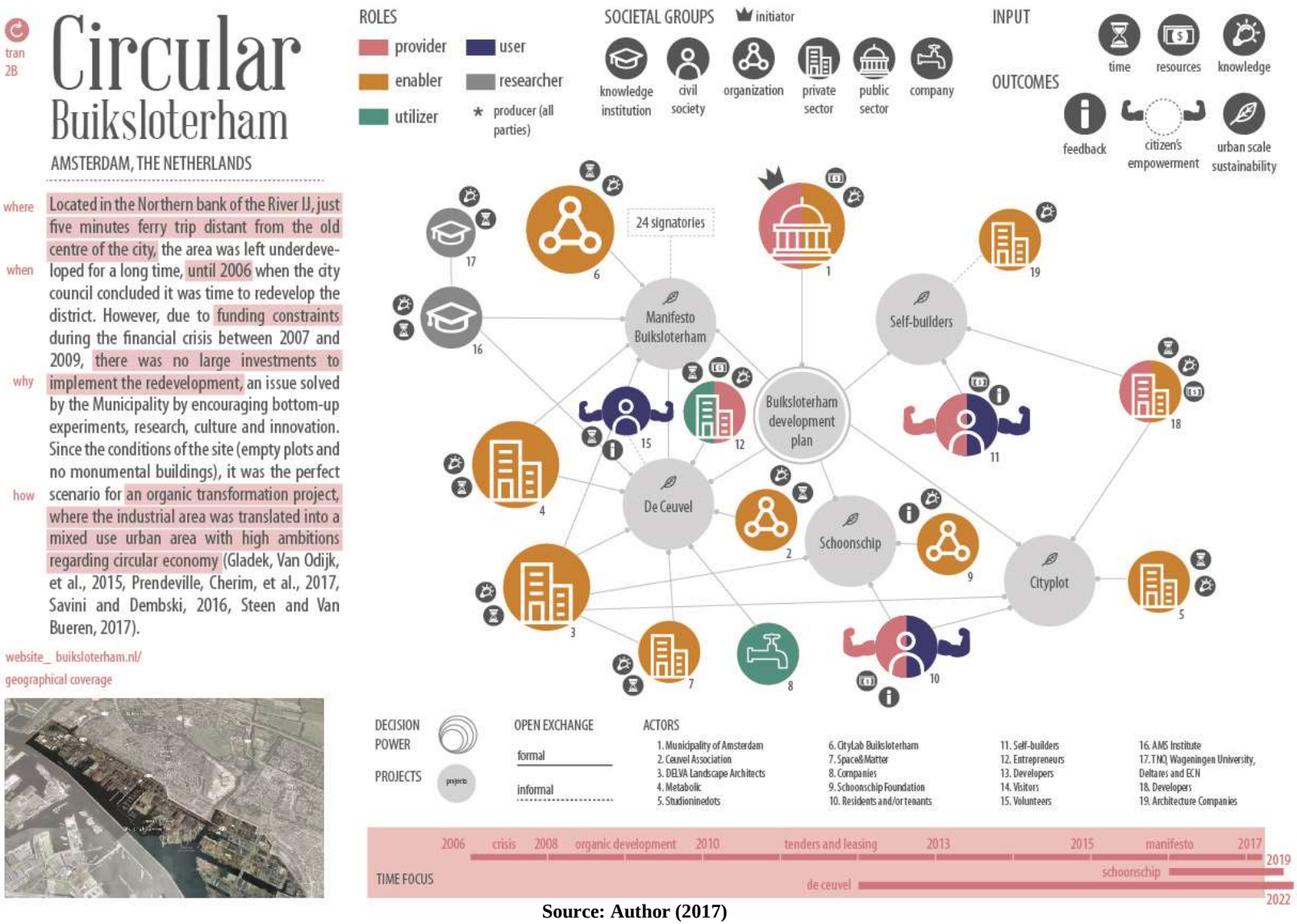
> *"We are organizing these 'make days', in which we invite people from the neighbourhood to come here and make their own, like lamps for instance, from recycle materials and this is how we teach them about sustainable upcycling and at the same time empowering them showing them that you can make a lot of stuff out of waste but it has not as successful as we wanted because there is no business model behind it" (CB Expert, 2017)*

Through the CityLab Buiksloterham, the participation of all the actors including the residents in the decision-making process regarding the community is ensured. The last characteristic to be analysed related to the context is the time focus. The timespan for the neighbourhood development, as part of the formal planning of Amsterdam is from 2005 to 2030. However, each project has its individual timeline. For instance, De Ceuvel has a ten years lease for the use of the polluted site, from 2012 to 2022. For the Schoonschip, the expected construction phase lasts between 2016 to 2019. For the self-build site, the average time for design and construction of a housing unit is 3 years, however each one follows its own speed.

Why is Buiksloterham a transition-driven ULL?

As well as ZOHO, Circular Buiksloterham is a transition-driven ULL because it allowed several actors to join a network who works together in favour of promoting and implementing the circular economy and urban experimentation, aiming the transformation of a polluted industrial site of Amsterdam into a sustainable and mixed-use neighbourhood.

Infographic 4: Living Lab Circular Buiksloterham

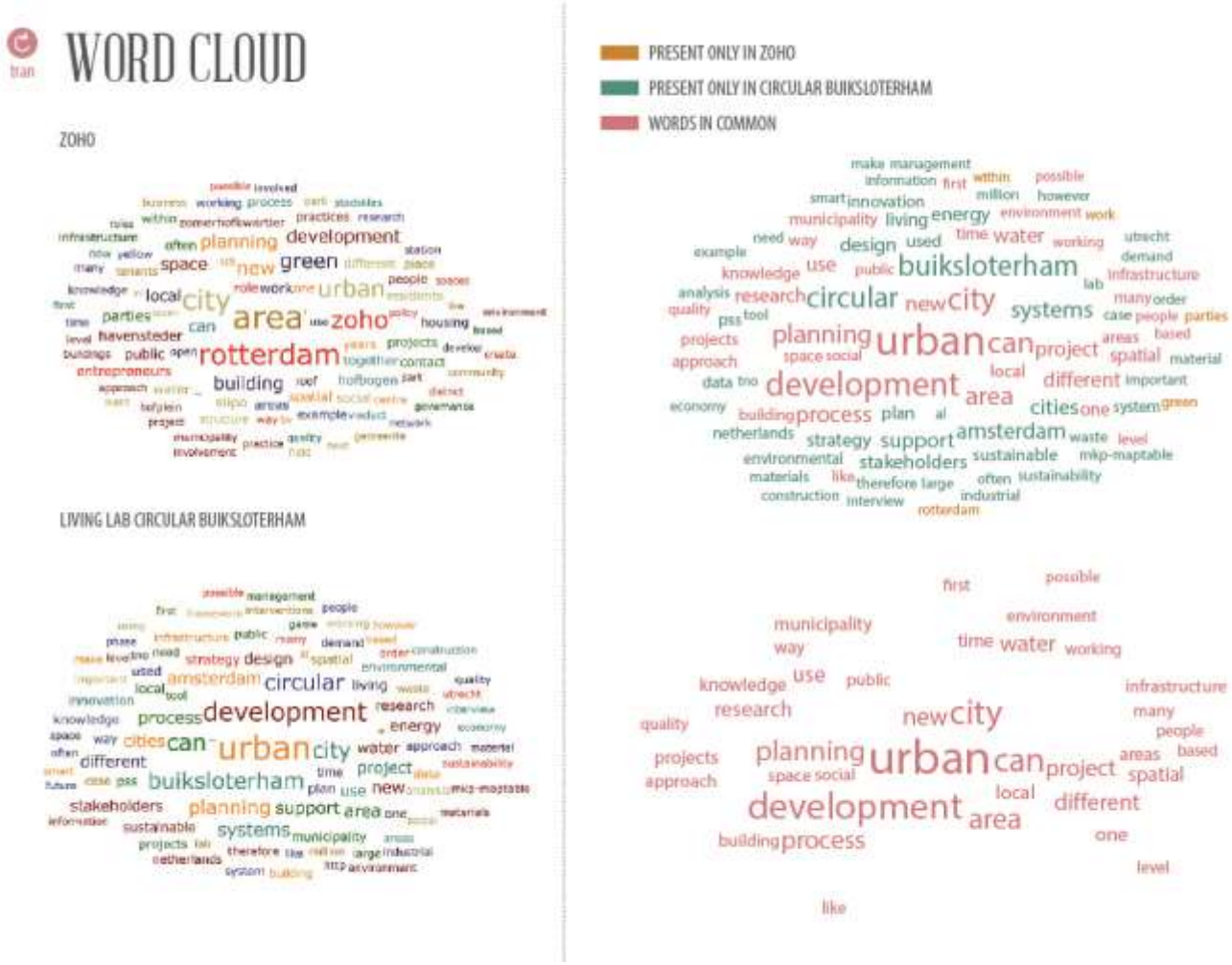


Source: Author (2017)

5.3.3 Comparison between cases

Table 7 presents the keywords commonly found in the literature about transition-driven Urban Living: *governance*; *urban experimentation*; *transition* and *sustainable development*, or other similar words. The same methodology explained in the Section 5.2.3 was used to analyse the database about transition-driven ULL. With this on mind, the first cloud about ZOHO was created with words that appear at least 18 times (10% of 183). The second cloud refers to Circular Buiksloterham and it was generated using words that appear at least 170 times (10% of 1706). The third one combines terms found in the two cases that appear at least 182 times (10% of the range between 1 and 1824). The words with the highest number of appearances in both clouds were highlighted in pink. Figure 26 shows the results obtained by combining both word clouds:

Figure 26: Word cloud transition-driven ULL



Source: Author (2017)

In the literature were found 38 most frequent used words common for both cases. Among these, *urban*, *planning*, *environment* and *development* are closely related to the keywords selected based on the theory. Even though, *experimentation* was not directly mentioned, terms like *knowledge*, *research*, *first*, *new*, *use*, *projects*, *project*, *process*, *working*, *approach* and *different* give a clue as how the processes of experimentation and learning take place within the cases. Terms related to the scale of intervention such as *space*, *spatial*, *building*, *area*, *areas*, *local* and *city* emphasize how geographical embeddedness is a strong characteristic trait of transition-driven ULL, as already mentioned in the theoretical discussion. Regarding the participants, *social*, *public*, *people* and *municipality* are widely cited due to the active role

performed by citizens and residents in both cases and the key role both municipalities, Rotterdam and Amsterdam, play in the transition-driven ULL. These terms are related to *governance* as well, one of the keywords not directly mentioned in the data. *Water*, *quality*, and *infrastructure* are words mainly used in both cases to refer to specificities of the cases since both are dealing with challenges related to water management and infrastructure, however it does not mean the words are related to the Urban Living Lab approach in general. The remaining words are generic terms: *like*, *way*, *possible*, *time*, *many*, *based*, *can*, *one* and *level*. Terms *living* and *lab* are not present in the cloud. It means that the Living Lab label is not being so frequently used to refer to these two projects. The following topics *Goal*, *Activities*, *Participants* and *Context* present the main conclusions drawn from the comparison between ZOHO and Circular Buiksloterham. The Table 14 below presents the count of the words common for both cases:

Table 14: Word count in the Transition-driven ULL literature

Group	Word	Number of appearances
Urban	urban	1824
	development	1288
	planning	873
	environment	221
Experimentation	new	691
	process	662
	different	578
	project	571
	use	490
	research	441
	knowledge	341
	projects	326
	approach	309
	working	230
	first	203
Scale of intervention	city	1133
	area	796
	local	419
	spatial	385
	building	309
	space	273
	areas	262
Participants	municipality	340
	public	279
	social	248
	people	225
Specificities	water	558
	infrastructure	259
	quality	216
Others	can	1090
	one	340
	way	332
	time	291
	many	261
	like	240
	based	217
	level	209
	possible	192

Source: Author (2017)

Goal

It can be asserted that ZOHO and Circular Buiksloterham interests are in parallel with the main goal of an Urban Living Lab. Both cases are trying a new way of developing a stagnated area near to the city centre. It is addressing an urban challenge that cities like Amsterdam and Rotterdam are facing: scarcity of urban land in central areas to still being developed. In the two cases, the initiators had already shown their intention to improve the areas and to take advantage of their privileged location within each city. However, the financial crisis around 2008 made it impossible to implement traditional urban planning, which always require large investments. In ZOHO and Buiksloterham the solution was to experiment with alternative sustainable development models: the first adopted the "slow urbanism" and the latter decided for an organic transformation. The adoption of these models is the main urban innovation in either cases. However, there are several paths leading to sustainability. In ZOHO's vision, the sustainable future is resilient and climate proofing, while Buiksloterham is focused on circularity. Even if climate proofing and circular economy are different "paths", they have in common the novelty to be applied in these large urban projects having an experimental character. However, the experiments ZOHO and Circular Buiksloterham could only be successful because of the strong local network created around these projects, involving partners from inside and outside the area, who shared not only resources but also the risks. In conclusion, the main goals of a transition-driven ULL are to experiment with alternative models of urban development and to be a tool for cities to better address current sustainability issues, such as resilience and circularity.

Activities

Diffuse roles are also characteristic of transition-driven ULL. Both Urban Living Labs are enabler-driven, meaning the network is formed around a regional development: Zomerhofkwartier and Buiksloterham districts. However, in ZOHO the initiator and main enabler is Havensteder, i.e. the private sector, because the housing association is major landlord in the area. The Municipality of Amsterdam plays this role of initiator and enabler in Circular Buiksloterham. Although Havensteder and *Geemente* Amsterdam are providers of resources and utilizers, their main contribution is to enable interventions in the sites where they have the bigger stake on the decision-making process. According to the literature review, in the enabler-driven Living Lab the information is collected and used together, and knowledge is co-created in the network (Leminen, Westerlund, et al., 2012). This description is suitable for the two cases, and they also present another common aspect: businesses, entrepreneurs and self-builders are enjoying an individual growth, but the positive impact goes beyond the individual scale, reaching collective gains. To summarize, the activities in a transition-driven ULL are happening simultaneously in different scales of intervention: individual, local and regional. The strong local network created around the project is responsible to transform the individual growth into a collective gain, producing knowledge regarding new ways of doing. The keywords for the activities in a transition-driven ULL are connect, create and learn.

Participants

Actors from public sector, private sector, knowledge institution and citizens, i.e. the QH, are present in the transition-driven ULL. Because the scale of intervention of each project are different, since ZOHO covers an urban area ten times smaller than Buiksloterham, they are substantially different in the number of actors involved. Around 100 tenants are living in the buildings part of ZOHO project, whereas Circular Buiksloterham had an initial community of 252 residents, but with an expected community of 6.429 inhabitants once the development is concluded in 2030. Another aspect that must be highlighted regarding the participants in a transition-driven ULL concerns the involvement of citizens. Their participation is not only

stimulated but bottom-up interventions, such as placemaking and self-build housing, are used as a tool to reach an active participation of citizens. The active involvement of citizens is crucial to unlock the full innovative potential of an ULL, since the citizens are an excellent source novel insights and precise feedbacks, but also, they are the societal group that will be most impacted (or benefited) by any of the two projects. Summarizing the findings about the participants in a transition-driven ULL, the initiators have a big stake, but they enable the participation of actors to make it possible the completion of the urban development plan. The citizens are involved in the project by acting in a bottom-up manner, through tenders, self-building, placemaking, volunteering, etc.

Context

An Urban Living Lab differs from other urban innovation methods because of its place-explicit urban focus. In the transition-driven ULL this characteristic is even more prominent because this type of lab the projects are part of a broader scale municipal urban development plan. It ensures a real-life linkage for the initiatives, since they are acting in parts of the cities dealing with actual development constraints. The national context had great influence on the emergence of ZOHO and Circular Buiksloterham. Zomerhofkwartier and Buiksloterham were being targeted by their initiators as potential areas for receiving redevelopment plans. However, these large-scale projects were put on hold due to the 2008 financial crisis in The Netherlands. According to Steen and Van Bueren (2017), in the absence of large investments, bottom-up experiments, research, culture, and innovation were actively encouraged, being that the role of Rotterdam and Amsterdam local governments. To conclude, the transition-driven ULL is part of a broader regional development however it adopts an alternative approach in in the boundaries between research, innovation and policy. The local government is responsible to create an environment conducive to urban experimentation, applying more relaxed or new regulations. It is a long-term development due to the size of the urban area and the network involved and complexity of the issues to be tackled by the ULL.

What is a transition-driven ULL?

The following Table 15 summarizes the main characteristics of the two cases and the main conclusions resulting from the combination of both case studies:

Table 15: Comparison table between Transition-driven Urban Living Labs

Variables	Characteristics	ZOHO (NL)	Living Lab Circular Buiksloterham (NL)	Summary and conclusion
Profile	*Initiator*	• Private sector (enabler)	• Public sector (enabler)	• Initiators are the main enablers
Goal	*Urban Innovation*	• To transform Zomerhofkwartier into a vibrant and resilient neighbourhood.	• To transform Buiksloterham into a sustainable and circular district.	• Development of an alternative model of urban development to transition towards a more sustainable one.

Variables	Characteristics	ZOHO (NL)	Living Lab Circular Buiksloterham (NL)	Summary and conclusion
	Open knowledge development and innovation for application	• Partners in and around the area; • Strong local network.	• Partners in and around the area; • Strong local network.	• Open exchange within a strong local network, with partners in and around the area.
	Local sustainability innovations	• Increased resilience and vibrancy.	• Shift from linear to circular economy.	• Experimental implementation of urban development models based on long-term sustainability, such as climate proof and circular economy.
Activities	*Co-creation*	• Enabler-driven; • Diffuse roles.	• Enabler-driven; • Diffuse roles.	• Enabler-driven; • Diffuse roles.
	Development of Innovation (exploration)	• Different scales of intervention; • Uses and/or processes.	• Different scales of intervention; • Uses and/or processes.	• Development of new uses and/or processes, implemented in different scales of intervention (individual, local and regional).
	Experimentation and Learning	• Coexistence of collaborative and individual processes; • Connect, create and learn.	• Coexistence of collaborative and individual processes; • Connect, create and learn.	• Systematic planning cycle starts with the creation of a network, followed by experimentation and informal learning activity; • The individual growth results in collective gains.
	Interaction between activities of evaluation and learning	• Learning with other ways of development, by trial and error.	• Starting from practice by trying out. • Assessment of impact of innovation on residents; • Intended monitoring system covering all the area.	• Different ways for monitoring: collection of feedback based on the interaction of visitors and residents with the spaces; or use of a planned monitoring system to assess the efficiency in the use of sustainable technologies.
Participants	*Users, private actors, public actors and knowledge institutes*	• Quadruple Helix actors; • 100 tenants; • Expected grown in the number of residents and businesses.	• Quadruple Helix actors; • Expected grown in the number of residents and businesses.	• Quadruple Helix actors are active contributors; • The increase in the attractiveness of the area can result in the growth of the local network.

Variables	Characteristics	ZOHO (NL)	Living Lab Circular Buiksloterham (NL)	Summary and conclusion
	User centred	• Participation of citizens is stimulated; • Place-making to create ownership over public spaces.	• Participation of citizens is stimulated; • Freedom to self-build their houses.	• Users participated through smaller bottom-up interventions.
	Decision power	• Different levels of decision power.	• Different levels of decision power.	• Initiator (and main enabler) has the bigger stake. All participants share a certain level of responsibility and decision power.
Context	*Geographical Coverage*	• Former business district near to city centre.	• Former industrial district near to city centre.	• The experimentation field covers a target area to be developed but can spread out from the original area to the surroundings.
	Real-life Setting	• Underdeveloped urban area.	• Underdeveloped urban area.	• Urban area with untapped potential for development.
	Part of an Ecosystem	• Integration with the formal planning; • Experimental approach to overcome crisis; • More relaxed regulations.	• Integration with the formal planning; • Experimental approach to overcome crisis; • More relaxed regulations.	• Part of the formal planning system covering a large area under development. • Experimental approach and more relaxed regulations helps to overcome implementation challenges.
	Time Focus	• 10 year-long development with different timelines per project.	• Long-term development with different timelines per project.	• Long term urban development

Source: Author (2017)

Comparing theory (Table 5) and empirical findings (Table 15) about transition-driven ULL, it is possible to conclude that the experimental approach is adopted in the transition-driven ULL to overcome a challenge in the implementation of the formal urban planning, for instance, a financial crisis. It results in a strong local network who shares with the local government the responsibilities, risks and gains from the project. The strongest feature from the definition of Urban Living Labs (Box 2) presents in the transition-driven ULL is the geographically bounded space because in this type this characteristic is stressed by the attachment of the project to a broader urban development plan.

5.4 Citizen-driven

As stated before in the literature review, this category of Urban Living Lab is *a tool for reaching the users and transforming the real urban environment* by involving citizens in the city development in a bottom-up manner. It provides open, participatory and do-it-yourself environment, including citizens (users) and local actors (producers) as co-creators of improved living spaces or services. The users are people who wants to solve their real-life problems, whereas other actors must acknowledge the user ownership in the process. The first example to be analysed is situated in Vitória City, Brazil. The initiative started when a NGO and CBOs working in a deprived area of Vitoria, named *Território do Bem*, decided to unit forces with a university in a quest for low-cost solutions to improve the housing conditions for low-income residents. The second case, Vrijburcht Community, consists in a co-housing initiative, where a group of citizens won a tender promoted by the Municipality of Amsterdam, The Netherlands, and developed an alternative community in terms of land ownership, financing, governance and architecture freedom.

5.4.1 Living Lab Habitat (BR)

Figure 27: Logo Living Lab Habitat

Habitat living lab

Source: LabTAR (2016a)

Figure 28: Location Território do Bem

Source: Google Maps (2017d)

Figure 29: Território do Bem community

Source: LabTAR (2013g)

The Living Lab Habitat (Figure 27) is a social network ecosystem for Research & Development and Education. It is the result of a relationship between the Federal University of Espírito Santo, the NGO Association Ateliê de Ideias and Território do Bem community (Figure 28). In 2005, a community-led bank was created to finance construction and renovation of houses, which are most often constructed under unsafe conditions (Figure 29). The NGO, who acts in the community since 2003, organizes meetings named *Forum Bem Maior* since 2006, where community leaders meet to discuss and propose solutions to the main problems and demands inside Território do Bem community and enhance people to try to find solutions which could improve the quality of life in the area. The Forum Bem Maior is a community-led space where residents could exercise a local governance. The first result the community achieved was a

housing programme, which includes credit, technical assistance for residents and construction of houses using clean technology, for instance, soil-cement bricks locally produced. The demand for knowledge in technical aspects of construction resulted in the first project integrating this community of users and the academic community of the Federal University of Espírito Santo, through the courses of Architecture and Civil Engineering. In 2010, LabTAR started its activities using public funding from FAPES and UFES. Professors, students and researchers work in the laboratory to support Living Lab Habitat and to develop and to try to implement environmental friendly technologies in collaboration with low-income communities (LabTAR, 2016b). The author conducted an interview by Skype with a researcher from LabTAR on 1st November (47 minutes of duration).

Goal

The main goal of Living Lab Habitat is to develop and apply environmental friendly technologies in collaboration with low income communities of Território do Bem, improving their housing conditions. There is no focus on one technology, product or phase of a product life cycle, however the technologies to be developed in the ULL must be related to any aspect of low-income housing issue and, therefore, must be necessarily focused on solutions with low maintenance and application costs, or to be related to any aspect of the environment and the life in the countryside (Habitat Living Lab, 2009e). Since the ULL is constantly looking for public and private sources of funding, the projects must adapt in order to fit in the notices of public and private tenders. The projects developed by Living Lab Habitat with community participation were: 1. Connect Ideas: online platform to connect and mobilize residents to contribute with ideas on how to transform the community; 2. Housing, Manufacturing and Water: a program to improve the quality of life in the community; 3. Meeting Brazil-Germany: a three days event to present projects for the urbanization of Território do Bem and, 4. Bem Forte: improvement and strengthening of the local currency, implemented by the residents with cooperation of the NGO Association Ateliê de Ideias. Each of these projects have a different product or knowledge as results, as further described in the Annex III (Table 26). However, the main goal of the initiative of create an intervention in the urban space could not be achieved until this moment, as explained in the interview:

> *"Now, for example, what I would like the HMW and the meeting to have generated was a continuation of another project of transformation of the public space, joining the city hall and the municipal technicians or the architecture and urban planning staff of the University and the community leaders It did not happen. we submitted the projects to the prefecture of victory to conquer the resource, including the project was written by city technicians with me and we cannot get the resources, right? politically the thing has not advanced. then, despite having a book, a joint publication, having had this mobilization, the concretization of this in a project of transformation there from some space of the territory, this did not happen. then they are partial gains, not that they did not exist, but they did not reach everything that we wish they had attained"* (LLH Expert, 2017)

The open innovation process was achieved in the ULL during the creation of the Connect Ideias platform, since it resulted from the interaction with final users, i.e. the residents, in the development and experimentation of a new technology.

Activities

As the other cases previously analyzed, the activities happening inside a citizen-driven Living Lab must also be: co-creation, exploration, experimentation and evaluation and learning. The co-creation activity consists in the participation of actors from several societal groups in the innovation development. This is happening in the Living Lab Habitat, however the degree of

involvement of actors varies. It can also be affirmed that an actor can perform more than one role in the complex networks created inside an Urban Living Lab. In the case of Living Lab Habitat, the main enabler is the researcher, responsible to produce knowledge regarding the projects. The topics under exploration in the Living Lab Habitat are social currency and credit, low-cost technologies and management of innovation and knowledge. The planning cycle from idea to product adopted in Living Lab Habitat starts from the organization of low-income communities in forums or other spaces of discussion that allow the identification of technological changes they require. This first step was initiated by the NGO Association Ateliê de Ideias in 2006, but it continued to be used after the UFES joined the initiative and the Living Lab was created. The following step is to identify possible sources of funding and to contact the participants (legal entity and individuals) from each organization that will participate in the project from its conception to writing, submission, acceptance, realization and accountability.

Regarding the evaluation phase, this activity occurs in an informal manner. If, on the one hand the meetings between the researchers from LabTAR, the community leaders and other partners have been used to identify the needs of the residents, on the other hand there is no feedback gathering from the community about the ULL activities. The interaction between evaluation and learning occurs as described in the interview:

> *"We tried to do this, to seek this feedback from the people, in some things was used, for example, the meeting it was an academic event held within the territory because we had already perceived the resistance of the people of the territory in coming to the UFES and occupy the space of the university. it was easier for teachers, students and everything else to hold the event inside, but we did it in a municipal school than using the things we already have here for us would be much easier, the auditoriums, the infrastructure of the university and bring them here. the projects began to be done using space of them. the coin project, the strong fort, all the meetings were held there on the hill. [...] so it is said that it was an apprenticeship that generated a different practice and it was this practice of using their spatiality and not ours. but this was not so written, we were seeing that we had to increasingly use the space there."* (LLH Expert, 2017)

Participants

The Federal University of Espírito Santo can be considered the initiator of the Living Lab Habitat because the knowledge institution, through the LabTAR, introduced the Living Lab "model and concepts" (LLH Expert, 2017) to the already existing projects in the Território do Bem. However, the Living Lab Habitat can be classified as user-driven since the network was initiated by the residents and the NGO when the demand for knowledge in the areas of Civil Engineering and Architecture and Urbanism resulted in the first project integrating the local community and the academic community. In addition, according to Leminen, Westerlund, et al. (2012), in a user -driven Living Lab the outcome is to solve user's everyday-life problems, what the Living Lab Habitat has been trying to do. The main provider, who bring infrastructure, financial support and other resources, is the Federal University of Espírito Santo, which hosts the LabTAR and the Living Lab Habitat. The source of founding determines the provider in a specific project, such as the several private sector actors and donor foundations partners of the initiative. For instance, the Foundation to Support to Research of Espírito Santo financed the project Connect Ideas. Besides LabTAR, other enablers are the Municipality of Vitória, who offered technical support for one of the projects, the NGO Association Ateliê de Ideias and partner start-ups. The researchers come mainly from the UFES. The post-graduate students from this institution are engaged in the Living Lab Habitat as a formal part of their curricular activities. Some international universities were partners in the projects, being the main one TU Berlin. The project Bem Forte, where only the community and the LabTAR were working

together without other actors involved, give us an example on how the network formed around a project can vary. The residents are involved from the beginning of the process through the forums and other movements of discussion, spaces where residents can interact and to be involved within the ULL activities, from planning, evaluation and implementation of technologies. Also, when the NGO AAI implemented a small factory for production of low-cost soil-cement bricks, the residents could actively participate in the construction of the houses, generating income and employment. Even though the project was implement out of the scope of the Living Lab Habitat, it is an important example to demonstrate how the community has being actively involved over the years in projects aiming to address its challenges. Regarding the division of power inside the network, LabTAR is the main facilitator and it develops tools to ensure the dissemination of knowledge and training in project management of the ULL managers:

> *"All decisions were made in meetings, the main ones being made here at the university. it was not like complicated meetings or a lot of power struggle. things were more or less aligned. the biggest difficulties were in relation to the commercial exploitation of products when we had a partnership with a company in the Mosaic project. in general, the thing has always been well shared."* (LLH Expert, 2017)

The Living Lab Habitat as organization can choose the communities through their representative movements[14] to work within Forum Bem Maior:

> *"The participation of the people of the territory was always mediated by leaderships ... and the community leaders were the ones that used the speeches of the living lab so that people called the residents, called the merchants, the people spoke to community leaders, leaders mobilized residents, for example, pro meeting 70/80 residents participated, but who made the invitation to the residents were not directly us, we had a proximity to the community leaders and this leadership that called the residents to participate."* (LLH Expert, 2017)

Context

Território do Bem is a hilly region of Vitória City, with around 31,000 inhabitants divided in 8 smaller communities, the majority in a situation of economic, social and cultural, educational vulnerability. The Living Lab Habitat is physically installed in the LabTAR, a laboratory located in the university UFES. Since 2003, the area has been targeted by NGO AAI interventions to improve the current situation especially regarding to the housing conditions. Over a five-year period, the community-led bank Banco Bem granted loans to 135 families. In general, 10,000 people in a situation of social and economic vulnerability have been helped. When asked about the areas inside the community where the activities of Living Lab Habitat took place, the interviewed answered:

> *"[...] the activities: in the facilities of partner companies, in the street, squares, public spaces, in general, we have done a lot of things in public spaces too, colleges, which are not open spaces, in the health post, in some space that could be used, we used [...] has the association of residents also, and public square, we closed the street to do activities there."* (Figure 30) (LLH Expert, 2017)

[14] Community leaders: people who were born there, who have lived there for a long time, who are involved with thecommunity (LLH Expert, 2017).

Figure 30: Second TED videos display in a street inside the community

Source: Barboza, B.S. (2015)

Regarding the role of the Municipal government, it does not officially support the initiative, who finishes for rely in alternative sources of funding in a risky and unpredictable manner. This way the two approaches are to adapt the projects to the funding opportunity, what can result in undesirable changes in the initial plan:

> *"[...] the city council specifically supported the meeting in a concrete way, at the meeting they were real partners because they provided buses for people to go to for the three days of events, they sent several employees, they prepared material, they participated city hall officials participated effectively, they even drafted a material, photographs, everything else. but with funding, with scholarship, this kind of support, no, we did not. we submitted projects and were not contemplated."* (LLH Expert, 2017)

At the broader level, the engagement of the local community in the forums empowers citizens to define the actions to be taken in the neighborhood, with a direct impact on their prospects for the future. It keeps the community at the center of technology development, achieved through a mixture of environmental education and community engagement, ensuring that the co-designed solutions respect local culture, rely on low-cost technologies, and promote sustainable development. In average, the projects have a short-term duration ranging between 1 and 2 years.

Why is Living Lab Habitat a citizen-driven ULL?

The Living Lab Habitat is a citizen-driven ULL because its organized approach, aiming to develop urban solutions, applying the experimentation and learning processes in the geographical bounded space the community Território do Bem. It offers to the residents a special platform to empower them while trying to solve their problems. The other actors, specially LabTAR, UFES and the NGO AAI acknowledge the user ownership in the process, when they involve the actors in a bottom-up manner in the process of innovation of development.

Infographic 5: Living Lab Habitat

citi 3A

LIVING LAB HABITAT

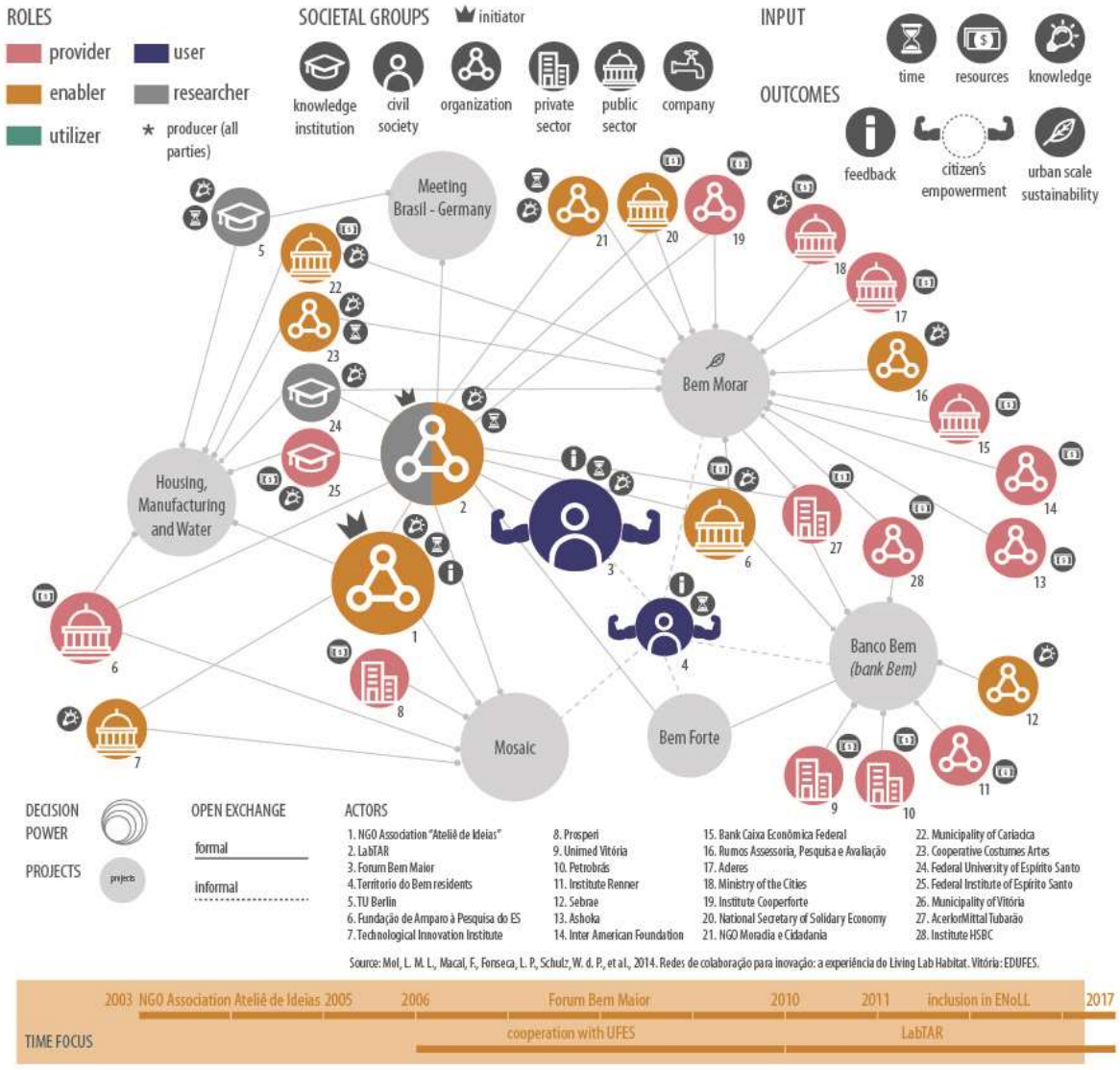
VITÓRIA, BRAZIL

where / how / why / when / how

It is the result of a relationship between the Federal University of Espírito Santo, the NGO Association Ateliê de Ideias and Territorio do Bem community. The NGO, who acts in the community since 2003, organizes meetings named Forum Bem Maior since 2006, where the community can exercise local governance. The demand for knowledge in technical aspects of construction resulted in the first project integrating this community of users and the academic community of the Federal University of Espírito Santo, through the courses of Architecture and Civil Engineering. In 2010, LabTAR started its activities using public funding from FAPES and UFES. Professors, students and researchers work in the laboratory to support Living Lab Habitat and to develop and implement environmental friendly technologies in collaboration with low-income communities (LabTAR, 2016b).

website_ labtar.ufes.br/ll-habitat/

geographical coverage



Source: Mol, Macal, et al (2014) with modifications by author (2017)

5.4.2 Vrijburcht Community (NL)

Vrijburcht (Figure 31) is a collective residential project, resulting from the collaboration between a group of activists from Nieuwmarkt, a historic district in the centre of Amsterdam. The architect Hein de Haan, together with about twenty of his neighbours, developed a plan for a sustainable affordable housing complex that also included workplaces, catering services and other functions. In 2000, the Municipality of Amsterdam launched an open call for developing experimental projects in IJburg, a waterfront location on the sheltered southern edge of Steigereiland (Figure 32), regarding new forms of urbanization, such as self-built and collective housing scheme. This strategy was chosen by the local government to tackle two problems concerning the housing situation in the city of Amsterdam: replication of monofunctional neighbourhoods and housing unaffordability. The proposal presented by the Nieuwmarkt group brought together the concepts the Municipality was looking for: more self-sustaining, social and affordable housing, and their idea was selected alongside 27 initiatives (Knoester, Miazzo, et al., 2014, Peborde, I., 2016b). In 2003, a Foundation (Vrijburcht Stichting) was established, formed by project participants, acted as a client when discussing the projects with architects, contractors and advisors during the development process. The Foundation was also responsible to secure the involvement of De Key Housing Association to provide financial assistance for the group of residents. However, the composition of the initial group changed significantly during the planning process, with a dropping in the original number of participants who were replaces by new members. Throughout all the process the Municipality supported the group providing professional guidance. The group was able to buy the land in 2004 and to move in the completed neighbourhood in 2007 (CoHousing Culture, 2017). An interview (70 minutes) was conducted on 26th October at VLUGP *Stedebouw & Landschapsarchitetuur* with one of the residents of Vrijburcht Community. The interviewed guided the author on a tour throughout the community (Figure 33).

Figure 31: Logo Vrijburcht Community

VRIJBURCHT

Source: Vrijburcht (n.d)

Figure 32: Location Vrijburcht Community

Source: Google Maps (2017b)

Figure 33: Vrijburcht Community

Source: Author (2017)

Goal

When the residents of Nieuwmarkt join together the first time, they envisioned to construct a co-housing complex below the market price, enjoying more flexibility for their individual wishes, such as design choices and property ownership. This collective vision was achieved, and their main accomplishment was the construction of a housing complex, with other parallel smaller projects (shared services and spaces) that make living and working conditions more attractive and stimulate social and cultural interaction. On top of this, Vrijburcht contributes to raise the quality of life in the entire neighbourhood of IJburg, since their reach goes beyond the limits of the community itself. On the other hand, the initiator of the ULL is the Municipality of Amsterdam launched in 2000 an open call for developing experimental projects, envisioning proposals for more self-sustaining, social and affordable housing in IJburg. Since the idea proposed by the Nieuwmarkt group was selected, it offered an opportunity to families who wants to live in Amsterdam to find attractive urban housing for reasonable sizes and prices.

The openness in the decision-making process took shape in Vrijburcht through the involvement of citizens in the design of their future dwellings in terms of layout, facilities and finishes. Once built the housing complex, the residents could meet each other within shared spaces and to connect with the surroundings, due to the combination of indoor and outdoor facilities. Besides the physical spaces, the community itself arranged virtual spaces to enhance social interaction: a website that includes an internal platform for the community member to facilitate the internal communication. The community gained visibility among other co-housing initiative for having been successful in its endeavour, using its website and guided tours inside the complex to share its lessons learned:

> *"[…] last summer we had people from Italy, from Trento, who wants to start con-housing in there and I take there to here and I showed them Amsterdam and around and we went to the Municipality also."* (VC Expert, 2017)

Vrijburcht Community contributes to the sustainable urban development of Amsterdam by offering affordable housing; increasing social cohesion and interaction within the neighbourhood; combine living and working in high density complex; and applying sustainable materials in the construction process. When asked about the sustainable strategies adopted during the design phase of Vrijburcht, the interviewed VC answered:

> *"It is a question of course that we all asked ourselves, because when you, going back to the period that we started in 2000, do you think the world was looking to self-sustainability? Not so much and I think from the 80s until then it was new working on the rain… everybody wants to have a better nature of course but it was not that we are looking to ourselves, of course people are doing that if you ask everybody: does everybody knows, but what can are we do about sustainability in the project? And there was one woman who said: I want a more sustainable material than PVC to put in the walls. And we said: What can we do to pick some water from the roofs and make some tanks in the garden to have water? And it was not directly going to the street and ran away and that we made […] Two years ago, we put some solar panels in the roof, 128, and connected 18 houses to it and this people were buying the energy from our homeowners association and for our homeowners association everybody is paying every year some money to maintain the building so we buy together the solar panels and then people pay some money lower than energy price in the market to finance the project again."* (VC Expert, 2017)

Activities

In the context of Vrijburcht Community, the co-creation activity consists in the participatory process initiated by the residents because it is not a standard housing development project, but it is a group of families who consciously choose to live together and feel responsible for the success of their project. Throughout the design and construction phases, other partners joined the citizens, sharing knowledge, costs and risks with them. For instance, Rabobank partly funded the preliminary phases and provided low interest mortgages to each family to cover construction costs:

> *"[…] we went to several banks and they said: first sell 70% then come back to us, we want to help you. At once, the Rabobank, they were very friendly to us, they liked our project very much and they were thinking: how can we help? So that was the start!"* (VC Expert, 2017)

The topic under exploration in the Vrijburcht Community is co-housing and its challenges. The community is innovative because it is a pioneering example of community-led housing project in Amsterdam, operating without a real estate developing company and achieving affordability through high housing density. During the construction phase, i.e. the implementation of the innovation, the municipality set up a team of experts (in construction, urbanism, social housing, land lease, public space) to assist the group with monthly meetings to solve questions and discussion of ideas. For this research, it was considered an activity of experimentation and learning for the residents:

> *"For our group, especially in the first one and a half year we had every month a meeting with the Municipality with a couple of people from different departments: social housing, urban spaces, infrastructure, all this kind, and then we had discussions about our project. So, it was very good that they did it like that."* (VC Expert, 2017)

As well as Living Lab Habitat, the evaluation activity is informal. The collective decisions about the community are discussed every two months in assemblies organized with every resident, consisting in a participatory process. Other specific topics are discussed by Vrijburcht Stichting through committees:

> *"In last ten years we grow to the structure that we have now. Because we have our housing association, a board of them with five people, four people live over here, then we have the Foundation from Vrijburcht, and from what we started, and we changed a little bit in a social foundation. And then also there are the owners of the hobby space and the parking place, one parking place, and they come into a foundation with the owners of the equipment of the theatre. […] So, the three of them, the triangle, every three months we come together, the board just to speak over the couple of standard things we have to speak and say how things are going and you can bring some problems or even ideas in it and we discussed together then it goes to the group just walking around and sometimes we organize social events, social evenings then everybody can come and discuss about these things. So that's how we make decisions over here. So, people like very much our 'sociocracy' then everybody has to say yes to the ideas."* (VC Expert, 2017)

Participants

Even though the Municipality of Amsterdam was the initiator of Vrijburcht Community, the Nieuwmarkt group took charge in the process when it won the open call. Throughout the community development, the residents invited other actors from private and public sectors to join the initiative. For this reason, this ULL is a user-driven, since the network was initiated by

the residents, to solve a citizen's challenge in afford housing in Amsterdam. The residents can also be considered providers because the construction costs for the housing complex was mainly covered by them, with support of other actors such as De Key Housing Association, Rabobank and Municipality of Amsterdam. Some enablers are from inside the community such as two architecture office, who brought technical knowledge translate the resident's idea into a masterplan. The outside enablers are the Municipality, who played this role when provided technical support to assist residents; the De Key Housing Association and De Roef, two organizations who worked together to manage the assisted living space for youth with slight mental impairment; and the Theatre Foundation, who operate and manage the Theatre Vrijburcht. In the context of the ULL, the Municipality is also utilizer, because it has used the community to learn about alternative forms of urbanization. It is clear the residents have a central position in the ULL and they were actively involved in all the decisions throughout the process: how to design the buildings, what materials should be used, which energy supplier should be contracted, etc. (Knoester, Miazzo, et al., 2014). For instance, the courtyard (Figure 34) design process was made by presentation, excursions, opinion polls and workshop until a common idea was formed: a lush green, natural and informal meeting space for all residents, young and old (VLUGP, 2017).

Figure 34: Vrijburcht Community courtyard

Source: Author (2017)

In order to facilitate the negotiation between residents and other actors, a board was elected to represent the community as a formal client when receiving professional advice from the Municipality and other professionals. This board, who later became the Vrijburcht Stichting, decides on social and technical issues, but it doesn't have unlimited power, since all the members of the group of residents had a vote in every decision concerning the community.

Context

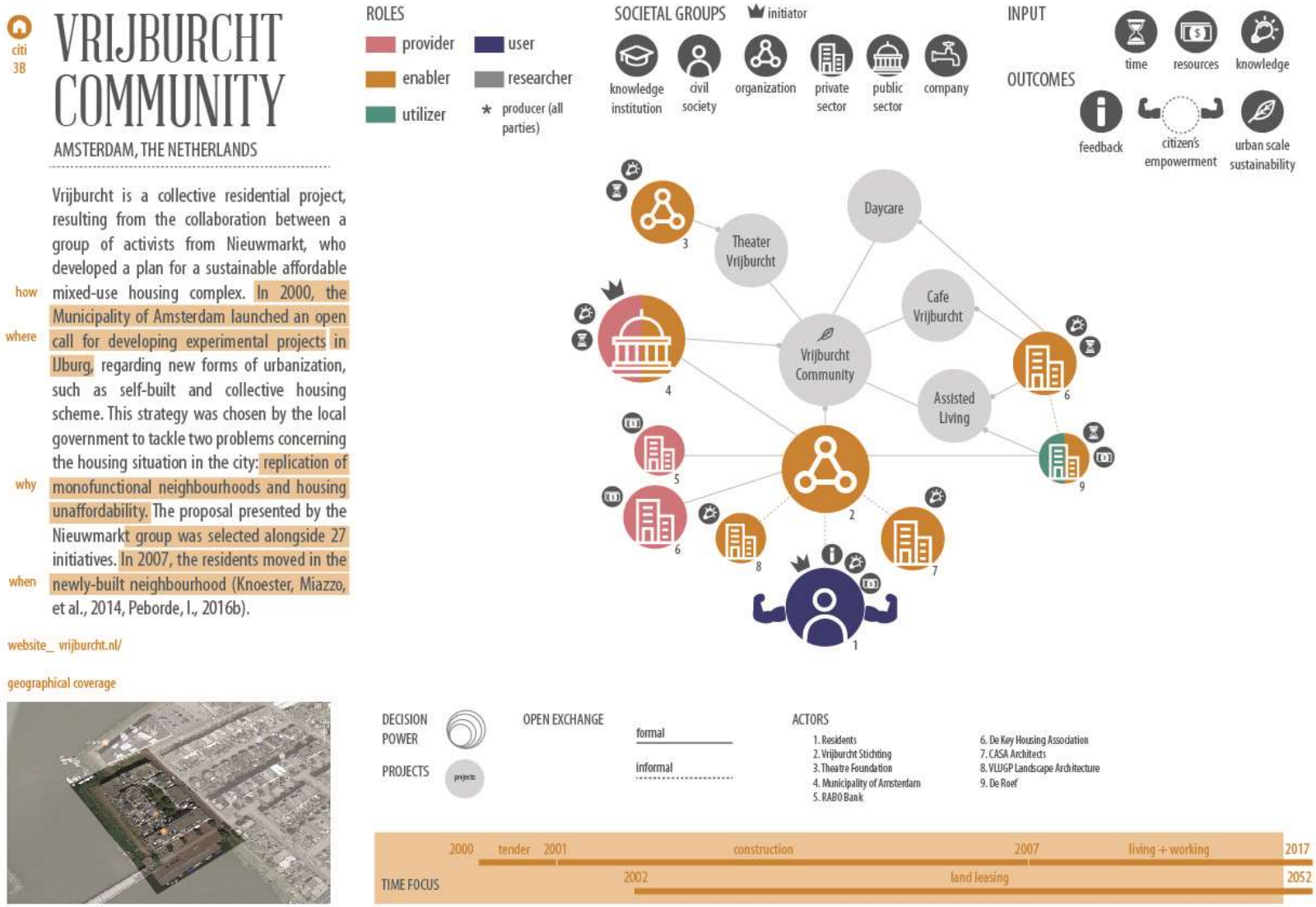
The housing complex with 52 dwellings (apartment, maisonettes and studios with an average size of 100m²) is located a waterfront location on the southern edge of Steigereiland, at less than 15 minutes by tram from the Amsterdam Central Station. The complex also includes other services, such as commercial units, two guest rooms, a hobby space, daycare for 42 children, cafe with waterfront terrace, theatre, a collective parking garage, greenhouse, courtyard garden, collective house for the young people of learning disabilities, docks for canoes and sailing club. However, the land around Vrijburcht is public, including the swimming areas and the docks, which are leased from the government. In Amsterdam, social rented housing represents about 50% of the total housing stock and the Municipality owns 80% of the land. This situation

facilitated the emergence of more social and alternative housing projects such as Vrijburcht. The role of the Municipality was to offer a 50 years lease of this piece of public land for the construction of Vrijburcht Community by the residents and partners. Because of that, the local government also offered professional advice to ensure all legal requirements are fulfilled during the design process. Regarding the empowerment of citizens, the long and collaborative process through which Vrijburcht was developed entailed a strong sense of community between the residents, making them work together to achieve collective benefits and to have an active voice in the decision-making process. The project had a long-term development since it took 6 years to be financed and constructed, between 2001 and 2007. In 2002, the 50 years lease for the site was given to Vrijburcht Community, so it is expected the community last at least more 35 years.

Why is Vrijburcht Community a citizen-driven ULL?

The Vrijburcht project gave the opportunity to citizens of Amsterdam to accomplish their aim: to build an affordable and community-led mixed-use complex well located in the city. During the design and construction phase, other actors were invited to collaborate, whereas they acknowledge the user ownership in the process. The Municipality used the project to experiment a new model of urban development, which allows citizens to hold more power. Other private sector partners, such as De Key Housing Association and Rabobank, seized the opportunity to try new processes for their businesses. As mentioned earlier in this section, a citizen-driven ULL connects local actors to co-create an improved living space or services, what it is right to say the Vrijburcht Community achieved this and can be labelled as a citizen-driven ULL.

Infographic 6: Vrijburcht Community

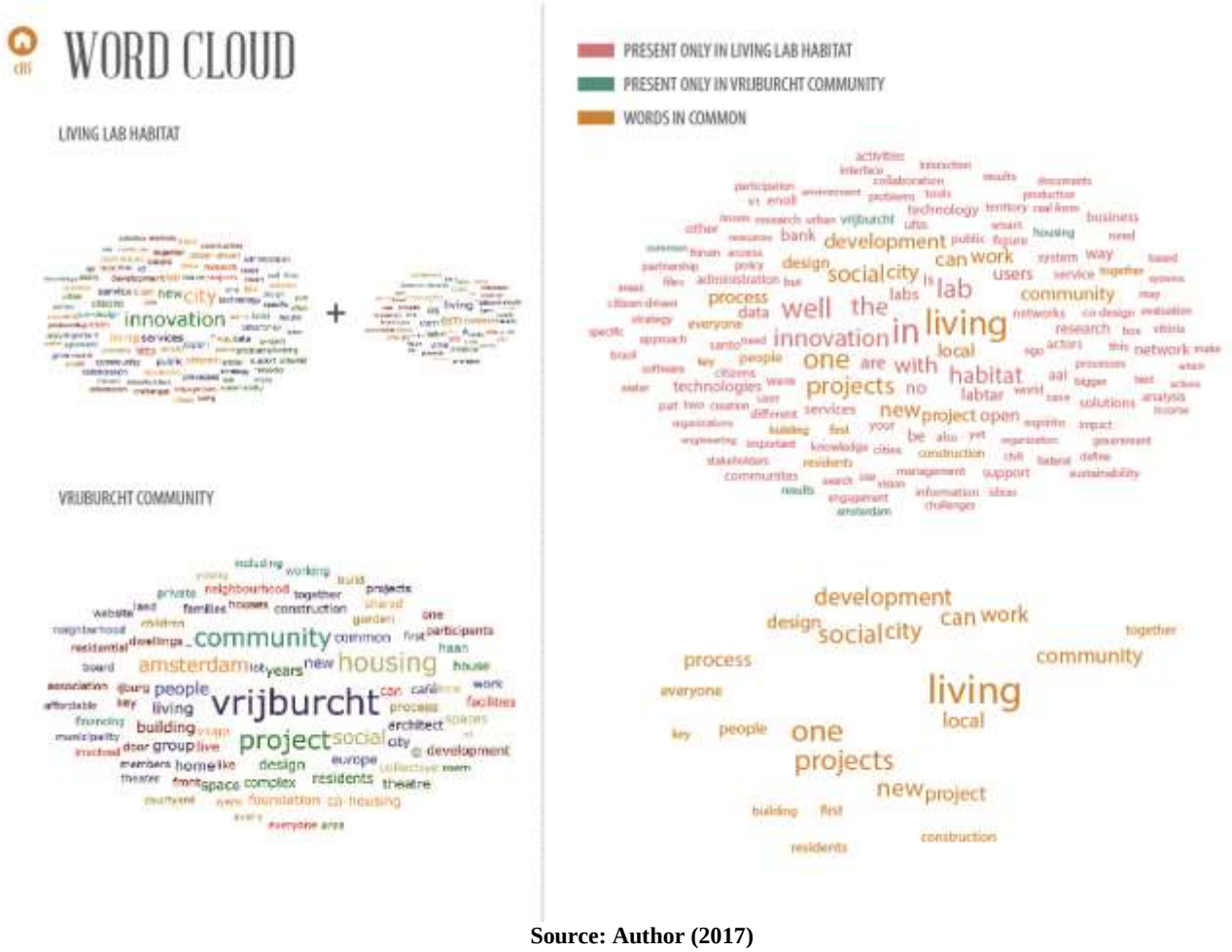


Source: Author (2017)

5.4.3 Comparison between cases

The word cloud of the Living Lab Habitat was created in a different way from all the others explained so far because most of the literature about the case was available only in Portuguese. In the literature in Portuguese, a selection was made to present only words who appeared 70 times or more (10% of 696). Then, another word cloud was generated with words with at least 31 appearances (10% of 309) in two sources in English. The Portuguese words were translated and combined with the words in English ones aiming to create only one word cloud from the Living Lab Habitat comparable with the one from Vrijburcht Community. For Vrijburcht, the word cloud was generated using terms that appear at least 8 times (10% of 85). Considering that some words are in Portuguese and others are in English, the Portuguese words were replaced by an English translation and then doubled terms were excluded. The final word cloud was compared with the clouds from each of the cases. A smaller percentage, only 5% of 696 (35 times), was used to create the combined word cloud in order to compensate the reduction in the amount of words caused by the translation of terms originally in Portuguese.

Figure 35: Word cloud citizen-driven ULL



Source: Author (2017)

Among the 22 most cited words in common for both cases, a few of them can be related to the previously identified keywords about citizen-driven ULL civic initiatives; citizen empowerment; bottom-up; self-organization and they are: social, community, together, residents, people and everyone. The significant amount of times these words were used to refer

to both cases shows how the civic participation is a key feature of citizen-driven ULLs. The words work, construction, building and design are closely related to the activities taking place in both cases, since Living Lab Habitat and Vrijburcht Community holds in common the housing issue as main topic to be addressed. The term living could be included in the group, however it is referring also to Living Lab Habitat. Local and city are terms which refer to the scale of intervention and the place-explicit urban focus intrinsic to the ULL approach. Terms like new, first, development, project, projects and process are present in all the three types of ULL studied so far, because of their innovative and experimental character. The remaining words can, key and one were considered generic terms. The Table 16 presents the count of the words common for both cases:

Table 16: Word count in the Citizen-driven ULL literature

Group	Word	Number of appearances
Experimentation	projects	319
	new	303
	project	299
	development	209
	process	196
	first	51
Living Lab	living	656
Scale of intervention	city	315
	local	130
Social	social	344
	community	198
	people	136
	residents	68
	together	66
	everyone	66
Specificities	work	195
	design	91
	construction	88
	building	59
Others	can	282
	one	73
	key	45

Source: Author (2017)

Goal

The main goal of an Urban Living Lab is to deliver innovation. However, with respect to the citizen-driven ULL, this innovation is oriented to solve citizens' real-life challenges. Both Living Lab Habitat and Vrijburcht Community had as aim the improvement in the quality of life of residents of the communities where the activities are taking place: Território do Bem and Vrijburcht. Regarding the openness of the citizen-driven ULL, the two cases have in common the dissemination of knowledge and lessons learned among the partners, but it is not limited to the ULL ecosystem itself: the experiences from Living Lab Habitat and Vrijburcht Community reach the outside community through researches about the cases. It not only helps similar projects to be implemented in the future but also attract people from other existing projects interested in the outcomes from both projects. The cases keep an important difference between them: Living Lab Habitat has a knowledge institution as initiator and main enabler, by means of LabTAR, whose one of the objectives is scientific disclosure. In that case, the process and all the knowledge acquired during it is relevant as the results, even if the process did not culminate in a successful outcome. For instance, the meeting between researchers from

Brazil and Germany had as goal to design and to implement urban interventions in the community Território do Bem. Although the interventions were not carried out in practice, the scientific knowledge produced during the meeting resulted in a book sharing the theoretical results obtained. Since Vrijburcht Community did not have a knowledge institution as partner throughout the process, it is best known because the outcome obtained in the end of the process was well-succeed and it attracted people interested in how the positive outcomes can be achieved in other contexts. Among the dimension of sustainability, the citizen-driven ULL cases cause greater impact in the social dimension, increasing social cohesion and interaction between citizens. In summary, the main goal of a citizen-driven ULL is to solve a citizen's real-life challenge while impacts positively in the social dimension of sustainability, with or without a scientific dissemination of knowledge during the process.

Activities

As in previously analysed types of ULL, the roles of the actors are diffuse, thus it can be concluded that diffuse roles are a key feature of Urban Living Lab in general. Even though the citizens were not the initiators of the projects, both cases are considered user-driven due to their purpose and outcome: problem solving to users' everyday-life difficulties by collaborative accomplishments (Leminen, Westerlund, et al., 2012). In Living Lab Habitat, the citizens initiated the network when they demanded technical support from the university, who afterwards turned the network into an Urban Living Lab. In the case of Vrijburcht, the Municipality of Amsterdam initiated the network, however it transferred the responsibility for the project to the residents. The decision-making process in the two cases is centred on meetings among residents and between residents and other partners, where the citizens' voice carries weight in the topics under discussion. It is during these meetings that the activity of evaluation and learning is informally conducted in both cases. To conclude, the activities in a citizen-driven ULL are informally arranged around the community of users, who meets to discuss important topics between them and with other partners.

Participants

The main difference between the Living Lab Habitat and Vrijburcht Community is regarding the societal groups that forms the network of the ULLs. As discussed above, there are no researchers participating in the Dutch case, while in the Brazilian case all Quadruple Helix actors are present in the network. In both cases the residents are the main group and their interests are being safeguarded by the other actors. Even though Living Lab Habitat and Vrijburcht Community have different scales of intervention, since the first one covers a neighbourhood with 8 smaller communities whereas the latter is one community with 52 dwellings, both projects have a similar method of ensuring a participatory process where the citizens have the final say since the beginning. Due to the large number of inhabitants in Território do Bem, they are represented by community leaders when dealing with other actors. A similar process is adopted in Vrijburcht even it has a smaller group of residents: a board with elected representatives acts as client when negotiating with other actors. Although the citizens have an active role in both cases, the enabler of Living Lab Habitat, i.e. the LabTAR, has the greater power in the decision making when deciding which projects are feasible to be carried out by the platform. Summarizing the main findings about participants in a citizen-driven ULL, the citizens form the main group and they have an active role since the beginning of the process. The other actors must safeguard that the interests of citizens are in the centre of the activities.

Context

In the citizen-driven ULL, the geographical coverage of intervention is the neighbourhood level. Both cases fit in this characteristic however they have different scales. Is can be explained

by the very different local contexts where each case is immersed, since the Brazilian cities, and consequently their neighbourhoods, are much bigger and more populous than the Dutch cities. Is it right that Vitória and Amsterdam offer very different living conditions to their inhabitants, however the residents from these two cities were facing challenges regarding housing when the ULL projects gave them the opportunity to overcome their difficulties by involving other actors and trying with innovative approaches. About the role of the Municipality, in both cases the local government did not fund the projects, meaning the citizens had to take charge and collectively cover a large part of the costs. In the Living Lab Habitat, alternative sources of funding were identified with the support from LabTAR, however since 2003 the costs to renovate some houses in the community are covered by the community-led bank. In Vrijburcht Community, the construction costs were assumed by the residents and the alternative sources of funding only were used to reduce the financial risks for the residents before the implementation phase. This dependency of external funding can either shrink or enlarge the time focus, depending of the self-sustain capability of the initial group. As long as the Brazilian case is completely dependent of external sources of funding or the limited funds from the residents, the average duration of the implement projects ranges between one and two years because that was the timeframe of the funding programmes. It took 6 years for the Dutch project be financed and constructed because the main source of money were the residents themselves.

Another significant difference between the cases regards the inclusion of the initiatives in the local formal urban planning. Vrijburcht Community is one single big project part of the urban development of IJburg and the Municipality of Amsterdam delimited the basic criteria that guided the implementation of the housing complex. Living Lab Habitat has several small parallel projects but none of them is included in the municipal budget or urban development plan. About the citizen-driven ULL context, it can be concluded the Municipality does not act as main provider of financial support for the ULL, that nevertheless can be included in the formal urban development plan. The costs must be covered by residents and other actors and this aspect determines the average duration of the projects.

What a citizen-driven ULL is?

The Table 17 summarizes the main characteristics and findings about the two cases and the conclusions that could be drawn from the study both cases:

Table 17: Comparison table between Citizen-driven Urban Living Labs

Variables	Characteristics	Living Lab Habitat (NL)	Vrijburcht Community (NL)	Summary and conclusions
Profile	*Initiator*	• Knowledge institution (enabler) + citizens (user)	• Public sector (enabler) + citizens (user)	• An initiator, other than the users, is enabling the participation of the citizens.
Goal	*Urban Innovation*	• Improvement of housing conditions through application of environmental friendly technologies.	• Construction of a co-housing complex; • Experiment with more self-sustaining, social and affordable housing.	• To find solutions that solve a citizens' challenge.

Variables	Characteristics	Living Lab Habitat (NL)	Vrijburcht Community (NL)	Summary and conclusions
	Open knowledge development and innovation for application	• Partners in and outside the area; • Dissemination of knowledge.	• Involvement of citizens in the design of the community; • Dissemination of lessons learned.	• Open exchange within the ULL's ecosystem and dissemination of knowledge and lessons learned with outside community. • Attraction of people from other similar projects interested in the outcomes.
	Local sustainability innovations	• Theoretical contribution to sustainable development; • Social cohesion.	• Affordability of housing in Amsterdam; • Social cohesion; • Adoption of sustainable materials.	• Largest impact in the social aspects of sustainability, such as social cohesion and interaction among the residents.
Activities	*Co-creation*	• User-driven; • Diffuse roles.	• User-driven; • Diffuse roles.	• User-driven; • Diffuse roles.
	Development of Innovation (exploration)	• The topics under exploration concern challenges for the citizens; • Management of innovation and knowledge.	• The topic under exploration concern a challenge for the citizens: co-housing and its management.	• Development of new products, services, uses and/or processes that help citizens to overcome their challenges.
	Experimentation and Learning	• Meetings between residents and other actors to identify which technological changes they require; • To identify possible sources of funding; • To contact other organizations that will make part in the project.	• Monthly meetings between residents and a team of expert from the Municipality; • Identification of possible partners.	• Informal planning cycle based on meetings between the citizens and other partners.
	Interaction between activities of evaluation and learning	• Informal gathering of insights and feedback.	• Informal gathering of insights and feedback.	• Informal activities of evaluation and learning.
Participants	*Users, private actors, public actors and knowledge institutes*	• Quadruple Helix actors, • Users consist the biggest societal group taking part in the projects;	• Public and private actors supporting citizens, • Users consist the biggest societal group taking part in the projects;	• The users consist in the main group and their interests are safeguarded by the other actors.
	User centred	• Participatory process since the beginning.	• Participatory process since the beginning.	• Participatory process from the beginning throughout all the steps.
	Decision power	• The enabler has the biggest stake; • Collective decision-making process.	• The users have the bigger stake and they take control in the decision-making process.	• The users have a strong power in the decision-making process.

Variables	Characteristics	Living Lab Habitat (NL)	Vrijburcht Community (NL)	Summary and conclusions
Context	*Geographical Coverage*	• Neighbourhood level	• Neighbourhood level	• The geographical coverage depends on the size of the community of users.
	Real-life Setting	• Vulnerable communities facing real-life challenges.	• Group of residents.	• Community of residents facing challenges in the urban setting.
	Part of an Ecosystem	• No official support from the Municipality, only jump in some projects; • Empowerment of citizens throughout the process.	• Official technical support from the Municipality, but not funding; • Empowerment of citizens throughout the process.	• The citizens must take charge of the project, even if it makes part of the formal planning systems, resulting in the community empowerment.
	Time Focus	• Short-term projects because the dependency of external sources of funding.	• Long-term project because the dependency of external sources of funding.	• The dependency of external funding can either shrink or enlarge the time focus, depending on the self-sustaining capability of the initial group.

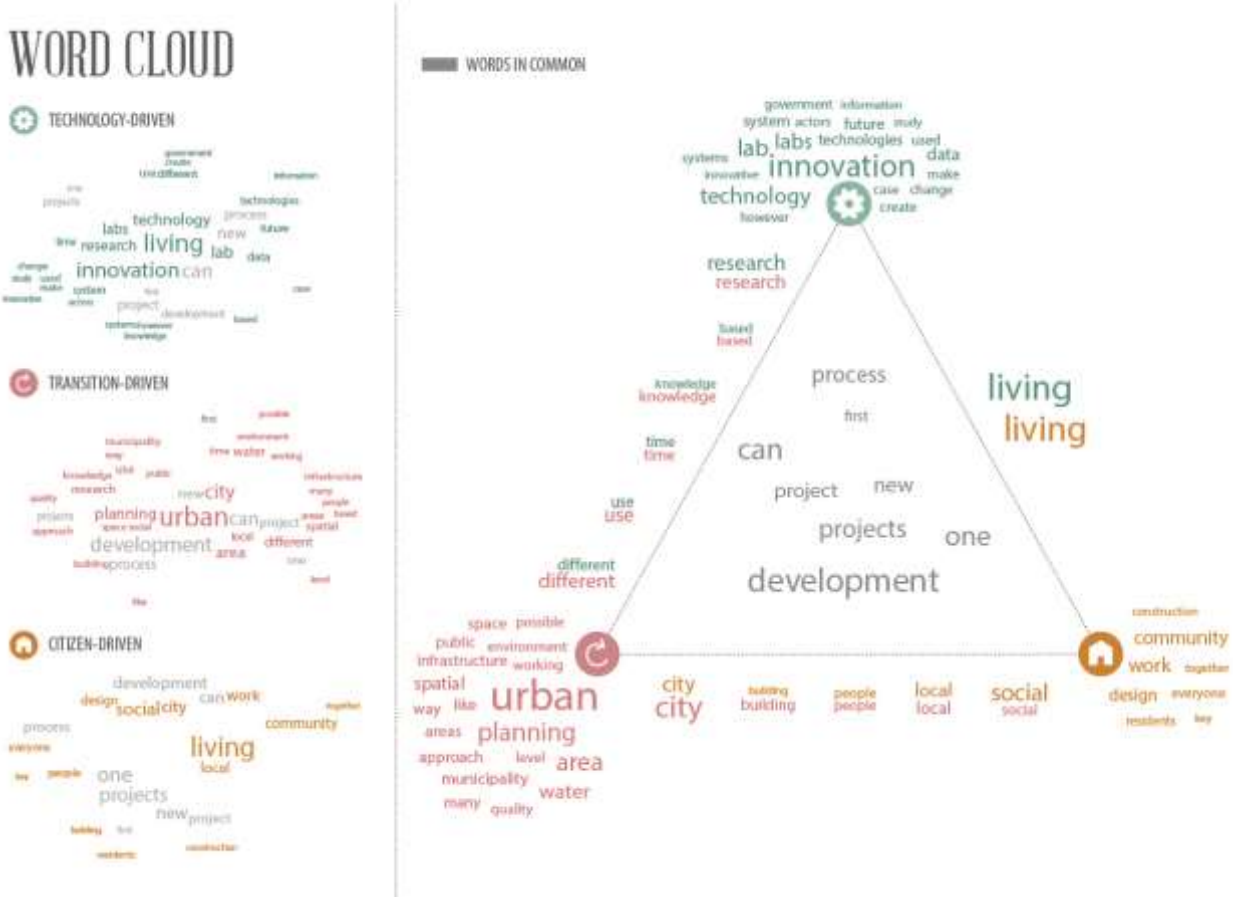
Source: Author (2017)

Comparing theory (Table 5) and empirical findings (Table 17Table 15) about citizen-driven ULL, the main remark regards the goal of this type of projects. More than delivery of innovation, a citizen-driven ULL aims to find solutions for challenges that citizens are facing in their daily lives. Bearing this on mind, the largest impact of this type of ULL is on social aspects of sustainability, such as social cohesion. Considering that a citizen-driven ULL is conducted by residents, there is a dependency from external sources of funding, either to implement the project or to reduce the risk of the initial investment. It can lead to a shrinking or a enlarging or the time focus of the Urban Living Lab, depending on the self-sustaining capability of the initial group. For instance, the Living Lab Habitat requires external funding to implement most of their projects, so it defines the duration of them (between 1 and 2 years). In Vrijburcht Community, the construction costs were totally covered by the residents, which required from them a longer time to save and invest all the needed resources (6 years). On the contrary of the technology-driven ULL, the citizen-driven ULL resembles more an *ad hoc* approach, especially Vrijburcht Community, because the group of residents was formed for the specific purpose to construct the housing complex. However, the citizens are more actively involved in the whole innovation process in the citizen-driven ULL when compared to the other two types.

5.5 Comparing the three types

When comparing the three types of ULL it can be noticed that they have the same outline with some specific features. Starting with a comparative word cloud (Figure 36) that combines all the selected words presented in Tables 11, 13 and 15, it is possible to visualize which words all three cases have in common (placed in the centre of the triangle), which words a case has in common with just one of the others (on the side they share) and which words are unique for each case. Analysing the common words in detail, they draw a general outline of Urban Living Labs: *can*, *project*, *projects*, *process*, *first*, *new*, *one* and *development*. These words resemble the organized approach based on the theory explained in Chapter 3: Living Lab as a real-life environment associated with a broad continuum of innovation activities (Leminen, 2015). However, in practice this happens in very different levels. For instance, The Green Village fits perfectly in this definition, while Vrijburcht Community has more of the *ad hoc* approach, as mentioned before. When the residents and the NGO AAI executed the first projects in Território do Bem, they had no plan to transform it in a ULL, but the demand for more technical knowledge motivated them to invite the University and to create the network. In addition, observing the comparative word cloud it can also be concluded that the transition-driven model has more similarities with technology-driven and citizen-driven than citizen- and technology-driven have between them. Annex IV presents a complete table with all the words from Figure 36 and the number of times each one of them appeared in the literature. In addition, the highlighted words in the table represents new keywords to define the types.

Figure 36: Comparative word cloud for the three types of ULL



Source: Author (2017)

The analysis presented in Sections 5.2.3, 5.3.3 and 5.4.3 were used to fill Table 18 summarizing the variables for each case. The purpose of this table is to bring back the definition of the variables based on the theory and to compare them with the findings from the empirical study, showing that each type has unique traits, even though they have a common outline.

Table 18: Characteristics per type of ULL

Variables	Urban Living Lab (theory)	Technology-driven (1)	Transition-driven (2)	Citizen-driven (3)
Goal	An Urban Living Lab aims to deliver innovation, such as new knowledge, products or services, oriented to urban challenges. The knowledge on the products and the processes used to develop these products is exchanged in a way as open as possible.	Aims to improve technology, to develop new products, services and/or uses and to attract new investments, being their innovative outcomes acting as allies in the pursuit of urban sustainability.	Aims to experiment with alternative models of urban development being a tool for the cities to better address their current sustainability issues.	Aims to solve a citizen's real-life challenge while impacts positively on the social dimension of sustainability.
Activities	The activities in a ULL are equivalent to those conducted in a LL: co-creation, development of innovation, experimentation& learning and interation between activities of evaluation and learning.	The activities performed in a technology-driven ULL follow a systematic planning cycle, allowing a repetition of the process as many times as necessary to achieve the goal.	The activities in a transition-driven ULL happen simultaneously at different scales of intervention: individual, local and regional. A strong local network created around the project is responsible of transforming individual growth into collective gain.	Activities in a citizen-driven ULL are informally arranged around the community of users, who meets to discuss important topics between them and with other partners.
Participants	The Quadruple Helix actors play diffuse roles. User role is played by the citizens, that can also be the utilizers when they initiate the process. Public sector, private actors and knowledge institutes can act as enablers, providers or utilizers, but all of them must be producers and may share the decision power.	In the technology-driven ULL, the initiator, who is also the main provider, has the bigger stake. The number of participants from other societal groups depends on the existing infrastructure (new or adapted) to receive the interventions and the number of projects simultaneously being developed.	In a transition-driven ULL, the initiator has a big stake, but it enables the participation of other actors to make possible the completion of the final goal. Citizens are involved in the project by acting in a bottom-up manner.	In the citizen-driven ULL, the citizens form the main group and they have an active role since the beginning of the process. The other actors must safeguard that the interests of citizens are in the centre of the activities.

Variables	Urban Living Lab (theory)	Technology-driven (1)	Transition-driven (2)	Citizen-driven (3)
Context	Based not only in a real-life setting, the ULL must also be embedded in a geographical area.	The technology-driven ULL has a temporary character, i.e. there is no intention to make the interventions permanent, which is reasonable given how fast technological development occurs nowadays. The local government is a close actor, playing different roles as provider, utilizer and/or enabler, especially regarding regulatory aspects.	The transition-driven ULL is part of a broader regional development, but it adopts an alternative approach in the boundaries between research, innovation and policy. The local government is responsible of creating an environment conducive to urban experimentation, applying more relaxed or new regulations. It is a long-term development due to the size of both the urban area and the network involved, and to the complexity of the issues to be tackled by the ULL.	The citizen-driven ULL is not financially supported by the Municipality, who is not the main provider of financial support for the ULL. Nevertheless, it can be included in the formal urban development plan. The costs must be covered by residents and other actors and this aspect determines the average duration of the projects.

Source: Author (2017)

Goal, *activities*, *participants* and *context* discussed in Table 18 were used to create a description for each type of ULL. The importance of this step is to compare it with the description extracted from the theory, as presented in Table 7, and to analyze how the characteristics found in the theory present themselves in practice.

The technology-driven Urban Living Lab was described as: a research environment to collect information about the users on the artefact or service which has been used to improve the urban environment or/and local services. After studying the cases of The Green Village and Stratumseind 2.0, it can be concluded the theory corresponds to reality in almost all aspects. Both are research environments, however Stratumseind 2.0 is enacted in a real-life setting while The Green Village is a test-bed located within the campus of TU Delft. The users in the two cases are under observation in their interaction with products and services. This process is being monitored and the data resulting from this interaction is used to improve the urban environment and local services by means of technology. Therefore, it could be added to the theory that the initiator is also the main provider, considering the constraints in the affordability of technology for other actors. Moreover, these constraints are related to the fixed-term character of technology-driven ULL for two reasons: first, to avoid the overburden of the main provider with expensive investments in technology and, second, to update the ULL accompanying the fast pace of technological development.

The transition-driven Urban Living Lab is: an ecosystem that connects different stakeholders, bringing together science, policy, business and civil society, to implement a new model of local governance, reaching self-organizing groups, normally detached from formal urban planning. It focuses on enhancing the transition towards sustainability by promoting urban experimentation, within a geographically bounded space emphasizing the development and test of innovative urban interventions. ZOHO and Circular Buiksloterham fit in this description, showing thus that the definition is applicable in real-life cases. Regarding the self-organizing groups, ZOHO though ZOHOCitizens board is giving more decision power to the residents and entrepreneurs in the decision-making process about the present and the future of

Zomerhofkwartier. A parallel can be drawn with ZOHOCitizens and CityLab Buiksloterham and Ceuvel Association, from Circular Buiksloterham case. The role of the Municipality proved to be a key feature for the transition-driven ULL and it should be mentioned in the definition.

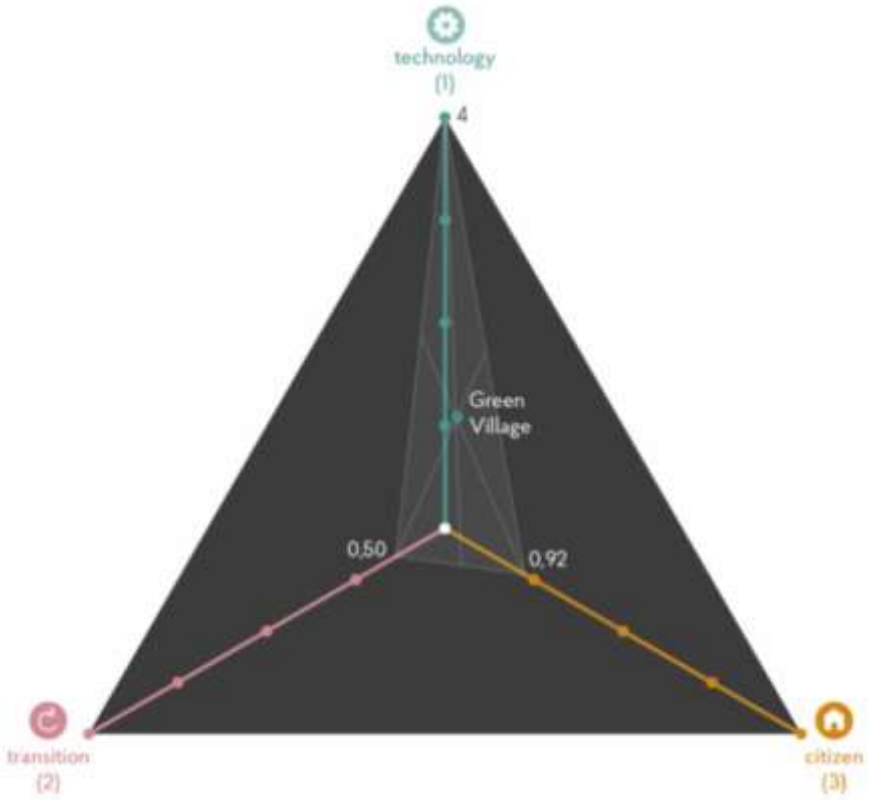
According to the theory, the citizen-driven Urban Living Lab is: a special platform that emphasizes residents and their communities as users, meaning people who want to solve their problems, whereas other actors acknowledge the user's ownership in the process. Although this definition can be used to describe both Living Lab Habitat and Vrijburcht Community, the cases have some unique traits not covered by theoretical research. The most important one concerns the lack of funding from the Municipality in both cases, meaning the costs of the project must be covered by citizens and other partners. The network of a citizen-driven ULL forms around the citizens and they guide the selection of topics under investigation, which guides the actions from other actors. Bearing this in mind, the independence of citizen-driven ULLs from a governmental funding plan should be included in the definition.

To conclude, there are indeed three types of Urban Living Labs as delineated by the theory. However, the reality is more complex and the distinction between the types is more blurred than the theory presents. This is because there are overlaps between the types since the analysis of them covers several, not mutually exclusive, characteristics, i.e. one case can fit characteristics from more than one type, even though the case has a main classification. A table was created to show this overlap between types in the cases studied. Table 30, presented in Annex V, has a quantitative approach and it consists in the first step towards a more elaborated study on the topic of ULL using the methodology created in this thesis. Table 29 (also located in Annex V) provides the criteria to analyse cases, and should be used combined with the Quantitative Analysis Table. In the Quantitative Analysis Table, each variable has the same weight (w=1). In the end, the maximum score each case can reach per type is 4. In this thesis, each case received a 4 in its own type of ULL, as a premise. The cases were then evaluated using the criteria from Table 29 and the quantitative results were used to position the cases in a graph (

Figure 37).

Figure 37 shows how to find the position of a case in the graph using The Green Village score as an example. The score per type should be marked in the graduated lines connecting the centre of the triangle to the edges. The resulting triangular shape obtained when connecting the three points from the score (0,50 / 0,92 / 4) has a geometric centre that corresponds to the position of the case in the graph. The graph is a visual representation of this overlap between types of Urban Living Labs. In the Green Village example, the dot is positioned in the area between technology-driven and citizen-driven, meaning that the Green Village is not purely a technology-driven ULL, but it has more prominent features from its own type.

Figure 37: Graph situating the Green Village as example



Source: Author (2017)

In view of all the analysis above, Box 3 presents a new definition for Urban Living Labs, recognizing the existence of the different types:

Box 3: Revised definition of Urban Living Lab

Urban Living Lab is an organized approach that offers three types of solution to address urban challenges: technology-driven, transition-driven and citizen-driven. They use several methods of real-life experimentation and learning applied in a geographically bounded space, besides including active citizens involvement in the innovation process.

Chapter 6: Conclusions and Recommendations

Several interesting conclusions can be drawn from the theory about Urban Living Lab and the empirical study of real examples. Even though Urban Living Labs are a young phenomenon, this study could outline the main characteristics that define them, identified in the academic discussion. Through a Desk Research, the relevant literature about Living Labs and Urban Living Labs was selected and systematically reviewed. Since the application of the Living Lab methodology in urban settings is recent, most of the literature produced about Urban Living Labs is derived from Living Lab's academic discussion. Considering this, at first the literature about Living Labs was analysed and afterwards combined with knowledge from the Urban Living Lab literature. As a result, Table 5 described the ULL's Goal (urban innovation; open knowledge development and innovation for application; local sustainability innovations), Activities (co-creation; development of innovation; experimentation and learning; interaction between activities of evaluation and learning), Participants (users, private actors, public actors and knowledge institutions; user centred; decision power) and Context (geographical coverage; real-life setting; part of an ecosystem; time focus).

In the systematic literature review about Urban Living Labs, a theoretical segmentation between the authors was also found (Table 7), based on their attempts to conceptualize and classify the Urban Living Labs (according to the type of solutions the ULLs are proposing to deal with urban challenges). Three different types were obtained from the literature and they are: technology-driven, transition-driven and citizen-driven. The technology-driven ULL means a research environment where information is collected from users and it is used to improve the urban environment or local services. A transition-driven ULL is an ecosystem where different stakeholders work together to implement a new model of local governance to transition society towards a more sustainable situation through experimentation in urban setting. The citizen-driven is a special platform that places residents and their communities in the centre of the urban innovation process, aiming to propose solutions to their main challenges. However, even with different features, the types overlap.

The next step consisted in an analysis of how the set of characteristics mentioned before presented themselves in practice. Six selected cases, two per type, were studied aiming to establish a relationship between their characteristics and their types, and then, aiming to understand what the types have in common and what are their unique traits. The Green Village (NL) and Stratumseind 2.0 (NL) are two cases selected as technology-driven ULL, ZOHO (NL) and Circular Buiksloterham (NL) were understood as transition-driven ULL and Living Lab Habitat (BR) and Vrijburcht Community (NL) are the examples of citizen-driven ULL. An extensive analysis of the characteristics of these cases is presented in Annex III. From all the tables presented as result, it can be concluded that the main characteristics, based on the theory, can be observed also in practice, and some patterns could be extracted from these characteristics, empirically outlining three types of Urban Living Labs, also. Considering this, the definition which stems from the theory required an adaptation to be in line with the empirical findings, resulting in the three new descriptions presented in Table 19. The Table also presents new keywords per type, combining words found in theory and in the case studies.

Table 19: Revised definition per type of ULL

	Urban Living Lab	Technology-driven (1)	Transition-driven (2)	Citizen-driven (3)
Definition	Urban Living Labs are an organized approach that offers three types of solution to address urban challenges: technology-driven, transition-driven and citizen-driven. They use several methods of real-life experimentation and learning applied in a geographically bounded space and active citizens involvement in the innovation process.	A temporary research environment initiated by a main provider to collect information about the users on the artefact or service which has been used to improve the urban environment or/and local services.	An ecosystem that connects different stakeholders, bringing together science, policy, business and civil society (including self-organizing groups), to implement new models of local governance and urban development attached to the formal planning. It focuses on enhancing the transition towards sustainability by promoting urban experimentation, within a geographically bounded space emphasizing the development and test of innovative urban interventions.	A special platform that emphasizes residents and their communities as users and providers, meaning people who want to solve their problems independently from public budget, whereas other actors acknowledge the user's ownership in the process.
Main urban Outcome	Urban Innovation	Technological Innovation	Experimental Urban Development	Citizen Empowerment
Keywords	urban experimentation; urban living lab; technology-driven; transition-driven; citizen-driven.	smart city; innovation; technological solution	governance; experimental urban planning, sustainable development; transition.	citizen empowerment; bottom-up; community-led; self-organized residents.

Source: Author (2017)

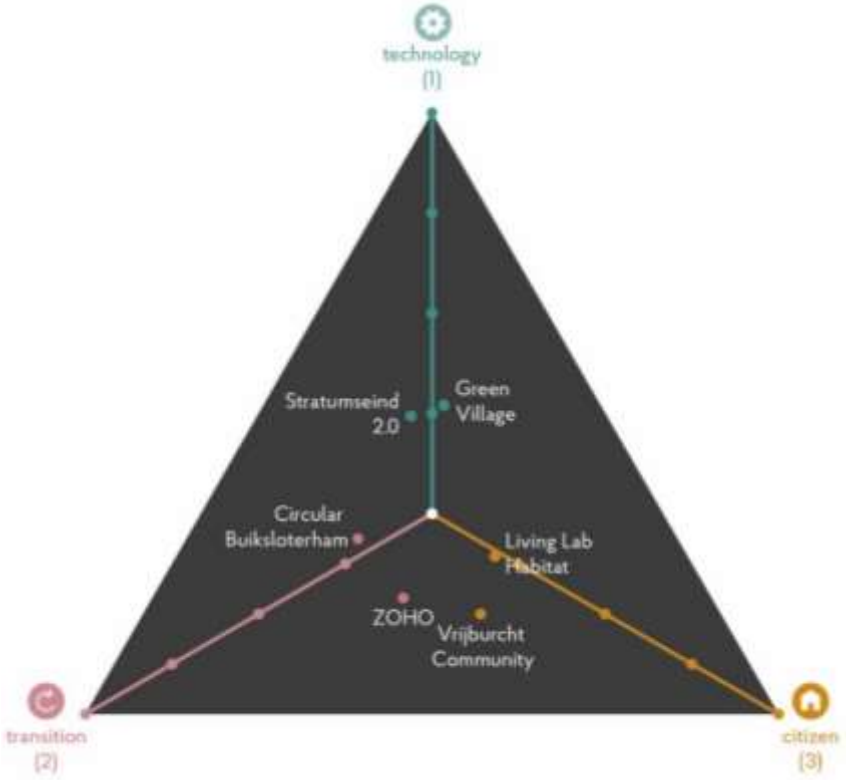
Some patterns can be observed between the main characteristics and types of Urban Living Labs, as summarized in Table 29 presented in Annex V of this thesis. All the elements presented in Table 29 arose from the same set of characteristics described in Table 5, however they are different from each other. A characteristic (based on the theory) when applied in practice is reframed depending on the way it was implemented. The variables acquire new nuances, because their shapes are not outlined by the presence or not of a characteristic, but they result of how the characteristics are being applied in real cases. Moreover, even if the characteristics per type of Urban Living Lab are different in Table 29, they are not mutually exclusive, meaning that a case can fit in two different types when observing one of its characteristics, such as urban innovation.

As explained in the problem statement of this research, the diversity of this topic makes it difficult to analyze the cases, and challenging to effectively categorize them. The solution proposed in this study is to classify Urban Living Labs based on these characteristics but recognizing that the distinction between types is blurred. A quantitative method was proposed with this aim in mind: to transcribe the overlap between types into quantitative analysis. The result of this analysis is presented in Table 30, located in the Annex V and it expresses in numbers the relationship between the characteristics and the types (concerning the kind of solutions that they propose to urban challenges) of different Urban Living Labs.

Bearing this in mind, the classification of Urban Living Labs is more complex than the three types drawn from theory. Observing the graph in

Figure 38, it can be concluded that the cases of Urban Living Labs are not a pure example of a type, but they are more hybrids between the three types, having one of those more predominant.

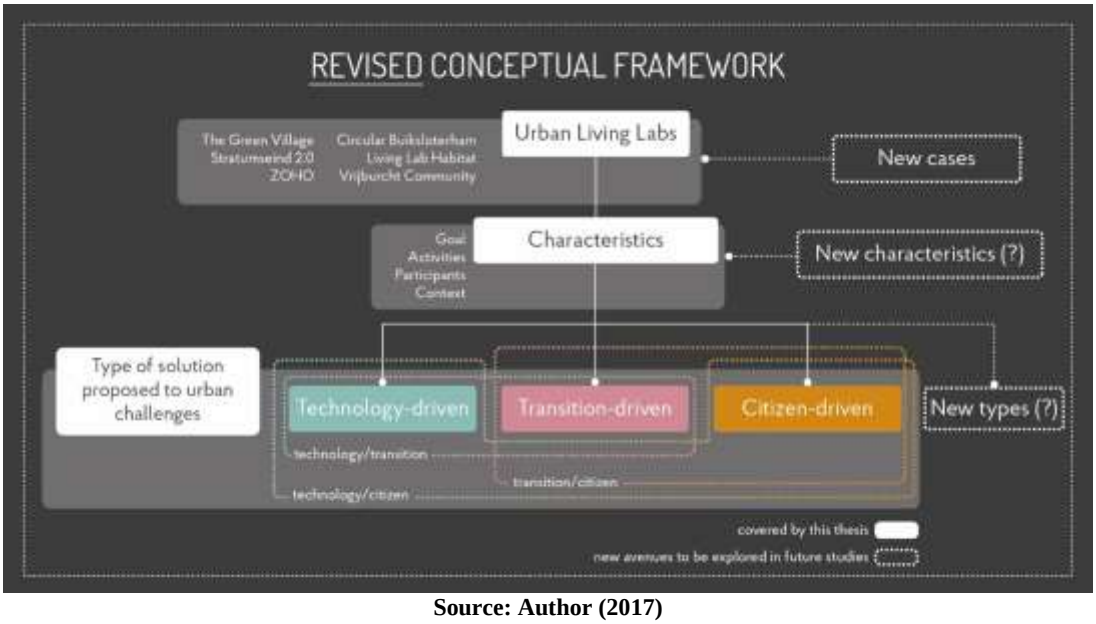
Figure 38: Graph situating all the position of analysed cases between the types of ULL



Source: Author (2017)

Figure 39 presents a revised conceptual framework acknowledging the main finding of this research: the coexistence of characteristics from more than one type in the same case of Urban Living Lab.

Figure 39: Revised Conceptual Framework including new avenues for future studies



Source: Author (2017)

Recommendations

Although this research brought a great deal of new knowledge about Urban Living Labs, some aspects are not well covered in the scope of this research, due to the limitation of time and resources available and to its exploratory character. For future researches aiming to study Urban Living Labs through the same approach, it is recommended to increase the amount of new cases studied. Moreover, it is suggested to contact actors from all societal groups that are part of the same ULL, because they may have different perspectives about the outcomes, the actors' roles and the main goal of the project(s), which will lead to a more accurate picture of each case. This ascertainment can be done with the cases studied in this research, by asking the actors from each case to appreciate the infographics and to refine them based on the actors' knowledge and own point of view regarding the initiatives.

This research gave a first step towards new methods of Urban Living Lab analysis, but there is still room for future researches to improve the methodology adopted in this study. As an example, the word cloud is an important tool to search for patterns and it can be improved from the way it was used in this research: it is recommended to use the world cloud within comparable amounts of data per cases, which was not possible in this study since the saturation point aimed was reached with different amounts of data per case. More significant results can be drawn, including a comparable counting of words, if the cases have the amount of data and the language in common. The quantitative method also requires improvement and that can only be done by including more cases in the analysis and making it more valid. This research did not anticipate the existence of more characteristics than the ones covered by academic literature thus far. New characteristics or variables can be identified through the study of more cases, requiring from future studies an adaptation of the methodology presented in this thesis. This study also opens an opportunity for future investigation about the hybrid types of Urban Living Labs, such as citizen-transition-driven or technology-transition-driven, and their particularities (Figure 39).

I would advise for future Urban Living Labs to use the analysis methodology developed in this thesis to firstly understand the local context, the urban challenges, the possible partners and the intended geographical coverage from the place where the ULL will be established in. This step could help future cases to select the most suitable type (technology-driven; transition-driven or citizen-driven) of Urban Living Lab for each specific local scenario.

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Annex I: Urban Living Labs "coding"

Table 20: "Coding" the Urban Living Labs definition

Author	Definition	Keywords
(Baccarne, Logghe, et al., 2016)	"Urban living labs have a distinct nature because the focus is on civic participation, and the output is aimed at increasing quality of life in the city rather than the development of a commercial product or service (Baccarne, Mechant, Schuurman, Colpaert, & De Marez, 2014). As such, urban living labs are an instrument to include a wide variety of stakeholders (citizens, municipalities, entrepreneurs, etc.) in the search for innovations that meet local socio-ecological challenges (Franz, 2014)."	User centred Increasing urban sustainability Users, private actors, public actors and knowledge institutes Co-creation Urban innovation/ Development of innovation
(Baccarne, Schuurman, et al., , 2014, p 4)	"[…] Urban Living Labs are oriented on 'urban' or 'civic' innovation. This means that Urban Living Labs are often supervised by (or have a close relation with) the local government and have a strong focus on social value creation and civic engagement."	Urban innovation/ Development of innovation Part of an ecosystem Increasing urban sustainability User centred
(Bulkeley, Coenen, et al., 2016, p 13)	"Urban Living Labs (ULL) are advanced as an explicit form of intervention delivering sustainability goals for cities. Established at the boundaries between research, innovation and policy, ULL are intended to design, demonstrate and learn about the effects of urban interventions in real time."	Experimentation and Learning Increasing urban sustainability Interaction between activities of evaluation and learning Urban innovation/ Development of innovation Real-life use context
(Franz, 2015, p 55)	"Living labs aim also to involve citizens in innovation development as a new element of the decision-making process by connecting research with the actual living environment. The rare examples of successfully implemented living labs being used in urban research aim to translate research into real-life needs through the inclusion of actors at various levels, representing not only citizens and researchers but also stakeholders, municipality and community actors."	User centred Urban innovation/ Development of innovation Real-life use context Experimentation and Learning Users, private actors, public actors and knowledge institutes
(Friedrich, Karlsson, et al., 2013, p 5)	"Urban Living Lab (ULL) is a forum for innovation that integrates the residents and other stakeholders to develop and test new ideas, systems and solutions in complex and real contexts (JPI 2013)."	Urban innovation/ Development of innovation User centred Users, private actors, public actors and knowledge institutes Real-life use context
(Juujärvi and Pesso, 2013, p 22)	"[urban] living lab as a virtual reality or a physical region in which different stakeholders form public-private-people partnerships of public agencies, firms, universities, and users collaborate to create, prototype, validate, and test new technologies, services, products, and systems in real-life contexts."	Geographical embeddedness Users, private actors, public actors and knowledge institutes Co-creation Urban innovation/ Development of innovation Real-life use context

(Marvin and Silver, 2016, p 58)	"[Urban Living Labs] are new collaborations devised to design, test and learn from social and technical innovation in real time. […] The ULL enrols end users into the innovation process and develops international networks for the transfer of technologies."	Co-creation Urban innovation/ Development of innovation Real-life use context User centred Open knowledge development for application
(Nesti, 2015, p 14)	"Urban laboratories involve citizens at different levels: as partners in the testing – encouraging them to give feedback to the Municipality about product effectiveness – or as co-producers. In the latter, citizens are invited to develop products or services for the city."	User centred Experimentation and Learning Interaction between activities of evaluation and learning Part of an ecosystem Co-creation Urban innovation/ Development of innovation Real-life use context Geographical embeddedness
(Nevens, Frantzeskaki, et al., 2013, p 115)	"The Urban Transition Lab is inspired by the 'living lab' concept […]. Often such labs operate in a territorial context (e.g. city, agglomeration, region) where they integrate concurrent research and innovation processes (Bilgram et al., 2008) within a public-private-people partnership (Pallot, 2009). They typically integrate research and innovation processes through a systematic co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artefacts in real life use cases. Such use of cases involves user communities ('participation'), not only as observed subjects or stakeholders that are enabled to have a say in the matters, but also as a source of creation."	Geographical embeddedness Experimentation and Learning Interaction between activities of evaluation and learning Co-creation Urban innovation/ Development of innovation Real-life use context Users, private actors, public actors and knowledge institutes User centred
(Schliwa, 2013, p 17)	"Hence, Living Lab projects and the development of the approach used in sustainability research is increasingly linked to a broader territorial perspective in order to use e.g. city districts or university campuses as arena for real-life experiments. This is mostly referred to the term Urban Living Lab. Applied as a method, the Urban Living Lab concept is used in urban areas to design a research and innovation system, which is capable to deal with the multi-dimensional challenges in cities."	Increasing urban sustainability Geographical embeddedness Real-life use context Urban innovation/ Development of innovation
(Steen and Van Bueren, 2017, p 11)	"All over the world, the term 'living lab' is being used to refer to a variety of local experimental projects of a participatory nature."	Geographical embeddedness Experimentation and Learning Users, private actors, public actors and knowledge institutes
(Voytenko, McCormick, et al., 2016, p 45-46)	"Urban living labs (ULLs) constitute a form of experimental governance, whereby urban stakeholders develop and test new technologies, products, services and ways of living to produce innovative solutions to the challenges of climate change, resilience and urban sustainability."	Users, private actors, public actors and knowledge institutes Experimentation and Learning Urban innovation/ Development of innovation Increasing urban sustainability

(Wallin, Horelli, et al., 2017, p 29)	"The urban living lab is an approach to test and embed new endeavours of urban development. They can be part of urban planning, urban design or the temporary use and production of urban space. The essence of urban living lab is in its implementation: the *in situ* gestalt and active stakeholders."	Urban innovation/ Development of innovation Part of an ecosystem Geographical embeddedness Real-life use context
Legend		**Most frequent characteristics**
Goal **Activities** **Participants** **Context**		**Urban innovation/ Development of innovation: 12** **Experimentation and Learning: 6** **Users, private actors, public actors and knowledge institute/ User centred: 14** **Real-life use context: 9**

Source: based on Friedrich, Karlsson, et al. (2013); Juujärvi and Pesso (2013); Nevens, Frantzeskaki, et al. (2013); Schliwa (2013); Baccarne, Schuurman, et al. (2014); Franz (2015); Nesti (2015); Baccarne, Logghe, et al. (2016); Bulkeley, Coenen, et al. (2016); Marvin and Silver (2016); Voytenko, McCormick, et al. (2016); Steen and Van Bueren (2017); Wallin, Horelli, et al. (2017) with modifications by author (2017).

Annex II: Code scheme

Table 21: Code scheme used to guide the coding of the secondary data about the selected ULL cases

Case Name:			
Focus: ☐ Technology-driven ☐ Transition-driven ☐ Citizen-driven			
Code group	**Codes**	**Questions**	**Explanation**
1. Profile	*1.1. When*	When did the ULL start?	The start date of the ULL activities.
	1.2. How	How did the ULL start?	Planning of the operation of the ULL.
	1.3. Where	Where the ULL is located?	The city where activities take place.
	1.4. Why	Why did the ULL start?	The initial main goal of the ULL.
	1.5. Initiator	From whom did the initiative start?	The actor who started the ULL and mobilized the others.
2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	Developing new knowledge and products into the environment of the ULL to find solutions to existing or new urban challenges.
		Does the ULL have more than one project? What are the guidelines to select a new project to start?	
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	
	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	Producing and exchanging knowledge of the developed products and processes to achieve these products in a way as open as possible.
	2.3. Local sustainability innovation	How does the ULL contribute to sustainable urban development, if at all?	Supported local solutions focused on promoting sustainable development.
3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized?	The participating actors together give shape to the innovation process.
		What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?	
	3.2. Development of Innovation (exploration)	SEE 2.1	Living labs aim to develop an innovation or a product, and not only, for example, to test or implement a pre-developed solution.
	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	Experimentation under real-world conditions, co-producing knowledge and ideas with the users, including e.g. new forms of collaboration, employment, education, etc.

	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	The ability of ULLs to facilitate formalised learning amongst the participants. The feedback gathered from use and evaluation of the product by the participants under real world conditions is used to further develop the products.
4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	Actors from these four groups are active contributors to the innovation and development process taking place within a living lab.
		How many participants are involved in total (per group)?	
	4.2. User centred	Are the citizens actively participating in all the stages of the processes take placing in the ULL?	The users are in the core of the process of planning and they appear in all the stages of the ULLs approach, participating and co-design with other stakeholders.
	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	All participants, including the citizens, have decision power in the various stages of the innovation process.
5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	The ULL situated in a geographical area where the processes in focus are taking place. This may be a region, an agglomeration, a city, a district or neighbourhood, a road or corridor, or a building. The area is normally well defined and has a manageable scale but the ultimate goal is to turn the whole city into a Living Lab.
	5.2. Real-life Setting	SEE 5.1	The living lab activities are enacted in a real-life use context, producing new urban environments, practices, patterns, etc.
	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	The ULL is part of the normal planning system and planning practices, covering cities or smaller units such as the transportation system. The ULL can be also part of the expanded urban planning when is embedded in the community development or local co-governance.
		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	
	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	Short vs long term actions, aiming to reach all the city with permanent changes of the urban environment.

Source: Author (2017)

Annex III: Case Studies

Table 22: The Green Village Analysis

CASE 1a				
Name	The Green Village			
Focus	Technology-driven			
Analysis				
Variables	**Characteristics**	**Guiding questions**	**Explanation**	**Data Sources**
1. Profile	*1.1. When*	When did the ULL start?	• End of 2016.	Content analysis; Academic Literature Review
	1.2. How	How did the ULL start?	• Creation by TU Delft of basic facilities in the campus.	Content analysis; Academic Literature Review
	1.3. Where	Where the ULL is located?	• Delft, The Netherlands.	Observation; Content analysis; Academic Literature Review
	1.4. Why	Why did the ULL start?	• To occupy a key position in the chain from fundamental research (mainly conducted within TU Delft ecosystem) to development and application of large-scale innovations in real-life by providing ground for studies into sustainable new technologies.	Content analysis; Academic Literature Review
	1.5. Initiator	From whom did the initiative start?	• TU Delft (in collaboration with Stichting Green Village).	Content analysis; Academic Literature Review
2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	• To accelerate the development and implementation of radical innovations required to solve the world's largest challenge, contributing to a sustainable future.	Content analysis; Academic Literature Review

		Does the ULL have more than one project? What are the guidelines to select a new project to start?	• Continuously realization and test of new technologies and systems, resulting in several projects, including PhD ones and master thesis; • Innovations related to the living environment and focused on societal challenges, looking towards technical solutions on a societal scale.	Observation; Content analysis; Academic Literature Review
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	• Research and development of system innovations regarding technologies, business models, public opinion, legislation and regulations; • New knowledge and products for utilizers (companies, researchers or public sector).	Observation; Content analysis; Academic Literature Review
	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	• Open exchange inside GV ecosystem: between members of the knowledge institution who are modifying fundamental research into applied research; between organizations to share knowledge on different aspects of sustainable technology research; • Open exchange outside GV ecosystem: outside partners add practical knowledge to the applied research and benefit from the innovation outcomes.	Content analysis; Academic Literature Review
	2.3. Local sustainability innovations	How does the ULL contribute to sustainable urban development, if at all?	• Improvement of the innovation process of sustainable technologies to: 1) produce clean energy; 2) use waste as a resource; 3) produce clean water; 4) produce clean air.	Content analysis; Academic Literature Review

3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized?	**Providers**: they offer infrastructure, financial support and other necessary resource; • **Provider-driven: network forms around the provider organization (TU Delft);** • TU Delft: create the basic facilities in the campus. Involvement with subsidies, an incentive to experiment and to take (more) risks; • European Regional Development Fund (in Dutch: *Europees Fonds voor Regionale Ontwikkeling*)/ Dutch province of South Holland: subsidies. **Enablers**: they bring tools, knowledge and methods for research; • Stichting Green Village: management of The Green Village; selection of projects and tenants; provision of public space where events can be organized; • DUWO: manage the rental units of the Living Lab; • User committee: to ensure interaction between different actors and stakeholders; • Municipality of Delft: "switch off" regulations to enable specific projects. **Utilizers**: they seek efficiency gains to develop its "business"; • Companies: open exchange of knowledge; collaboration to create new products; • Municipality of Delft: adoption of a structured approach to ensure the participation of citizens in the Environmental Law 2019; **Users**: • Visitors and users: to participate in the innovation process of the demonstrated technologies giving input for the development of innovations and suggestions for improvement of products; • Students: real inhabitants of the houses situated in the test site, they must provide feedback. **Researchers:** research on technical topics related to the focus of the ULL, or policy and business research; • Students and researchers: perform their own researches, such as master thesis or PhD project. **Producers**: all actors actively join contributing with knowledge and time.	Guided tour; Observation; Content analysis; Academic Literature Review
		What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?		

	3.2. Development of Innovation (exploration)	SEE 2.1	• Development of innovation in services and products in the field of sustainable energy provision, water and waste systems; • Room for experimentation with products and business models; • Unified strengths from scientists and entrepreneurs to turn ideas and visions into experiences and commercially viable products and services.	Content analysis; Academic Literature Review
	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	• Research programs: created by TU Delft researchers, who subsequently modify them into applied research; • Physical demonstration: a dynamic site, where the projects created in the research programs and all projects can be tested.	Content analysis; Academic Literature Review
	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	• The activities of visitors in the physical demonstration site are registered: e.g. energy consumption, use of technologies, flexible living spaces, etc. The data is registered and thereafter there is an investigation using questionnaires, interviews and market research; • Due to these visitors, it is also possible to experiment with business case for future technologies.	Content analysis; Academic Literature Review
4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	• Citizens: visitors, students, civil society organizations, users; • Knowledge institutions: TU Delft (students and researchers), The Hague University of Applied Sciences; • Organization: Stichting Green Village, DUWO, ABT; • Businesses: start-ups, large multinationals, entrepreneurs, trade associations; Hardt, Fieldfactors, AquaBattery, PHYSEE, TOBLOCKCHAIN, Hyundai, Climotion, Homie, Accenda; • Companies: GasTerra, Alliander N.V., Stedin, BAM, Eneco, Sustainder, Huawei, Bouwfonds, Luminext, Suez, Engie, Nowi; • Public sector: Municipality of Delft, National Ministry of Infrastructure and Environment, Government of The Netherlands, Province of Zuid-Holland, Delfland Water Authority (in Dutch: *Hoogheemraadschap van Delftland*), InnovationQuarter, European Regional Development Fund, The Metropolitan Region Rotterdam and The Hague (MRDH), Government Real Estate Company (in Dutch: *Rijksvastgoedbedrijf*), European Commission.	Guided tour; Observation; Content analysis; Academic Literature Review
		How many participants are involved in total (per group)?	• Between 100 to 120 companies and organizations.	Content analysis; Academic Literature Review

	4.2. User centred	Are the citizens actively participating in all the stages of the processes taking place in the ULL?	• Citizens are welcome involved to participate in the innovation process of the demonstrated technologies by giving input for the development of innovations and suggestions for improvement of products.	Content analysis; Academic Literature Review
	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	• The model implemented in the GV cannot be engineered by one actor but instead evolve because of the (inter)actions of all involved actors, where each actor can only partially influence the path of the system over time.	Content analysis; Academic Literature Review
5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	• Outdoor laboratory located on the Van Broekweg in the TU Delft campus, covering a surface area of approximately 11,800 m²; • The demonstration site offers offices, shops, houses, streets and lighting system; • Two circular designed student housing are independent wood studios of 30m² located in the site.	Observation; Content analysis; Academic Literature Review
	5.2. Real-life Setting	SEE 5.1	• The activities performed in the GV are enacted in a real-life context, producing new technologies in the field of sustainable energy provision, water and waste systems; new business models and urban environments; • Real companies are presenting real cases to be tested. Some projects won international competition.	Guided tour; Observation; Content analysis; Academic Literature Review
	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	• Support from several public-sector actors: European Regional Development Fund, the Province of Zuid-Holland, Municipality of Delft, National Ministry of Infrastructure and Environment, Government of The Netherlands, Delfland Water Authority, InnovationQuarter; • The public sector can also act as utilizer: testing the Environmental Law 2019 (in Dutch: *Omgevingswet/Delfts Doen*) by the municipality of Delft; two large research projects opened by the Minister of Infrastructure and the Environment: Europe's first hyper loop-test facility and a research laboratory for experiments with automatic transport.	Guided tour; Content analysis; Academic Literature Review
		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	• The citizens can better address their needs when they are actively involved in the project under development, for instance, the Environmental Plan 2019 will be co-created in the GV, with participation of residents and businesses.	Content analysis; Academic Literature Review

	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	• The Green Village was built as a temporary village, possibly for a period of 5 to 10 years; • The tenants in the Green Village houses can live up to one year in the studios; • Revolving population and projects is desired.	Content analysis; Academic Literature Review

Source: Coomans (2015), DUWO (2017), Geemente Delft (2017a), Geemente Delft (2017b), GV Expert (2017), Koppers (2015), The Green Village (2017a), The Green Village (2017b), TU Delft (2017), van Wijk (2013), with modification by author (2017)

Table 23: Stratumseind 2.0 Analysis

CASE 1b				
Name	Stratumseind 2.0			
Focus	Technology-driven			
Analysis				
Variables	**Characteristics**	**Questions**	**Explanation**	**Data Sources**
1. Profile	*1.1. When*	When did the ULL start?	• December 2013.	Content analysis; Academic Literature Review
	1.2. How	How did the ULL start?	• In 2012, the city of Eindhoven decided to improve the safety in the street Stratumseind; • The municipality of Eindhoven realized the importance of the Smart City concept for the city; • Mobilization of actors and funds to materialize the project.	Content analysis; Academic Literature Review
	1.3. Where	Where the ULL is located?	• Eindhoven, The Netherlands.	Observation; Content analysis; Academic Literature Review
	1.4. Why	Why did the ULL start?	• Fights, neglected buildings and less walkers in the street; • Reduced turnover to the business in the area; • Need to further develop and "brand" Eindhoven as Smart City.	Content analysis; Academic Literature Review
	1.5. Initiator	From whom did the initiative start?	• Municipality of Eindhoven (through civil servants)	Content analysis; Academic Literature Review
2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	• To improve and increase the economic and social activities on Stratumseind making the street more safe, liveable and attractive; • Defusing escalating behaviour by using interactive light scenarios.	Content analysis; Academic Literature Review

		Does the ULL have more than one project? What are the guidelines to select a new project to start?	• Stratumseind 2.0 is one of the various living lab projects in Eindhoven, labelled as Smart City initiatives.	Content analysis; Academic Literature Review
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	• Creation of a new network between various actors interested in improving the area; • Testing and application of innovative solutions involving lighting (dynamic lighting system), social media (twitter analysis, etc), gaming technology and the collection and processing of sensor (light, noise, wi-fi, etc) data.	Content analysis; Academic Literature Review
	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	The data used in the Living Lab comes from a variety of sources: • Inside: sensors (image, sound, smartphones and wi-fi, lighting) located in the street; • Outside: social media, police records, breweries, open data from municipality, investigations of the TU/e and Fontys; • The data is openly and democratically accessible, available for anyone appreciation through open source software.	Content analysis; Academic Literature Review
	2.3. Local sustainability innovations	How does the ULL contribute to sustainable urban development, if at all?	• Improvement in the safety, economic viability and attractiveness in Stratumseind street to boost its prosperity and well-being for the actors; • Boost innovation in the region, stimulating future similar initiatives.	Content analysis; Academic Literature Review
3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized?	**Providers**: they offer infrastructure, financial support and other necessary resource; • **Provider-driven: network forms around the provider organization (Municipality of Eindhoven);** • Municipality of Eindhoven: control of information gathered; provision of backdrop for outdoor testes; management; financing around 50% of the project; in-kind contribution; • Netherlands Organization for Scientific Research (NWO), Province of Brabant and Ministry of Security and Justice: funding; • Companies (Philips, Atos, Bosch, VNotion, Munisens, Geodan, Coosto, Vodafone, Het Lux Lab): bring technology, knowledge and practical experience; • Eindhoven 365: marketing strategy; **Utilizers**: they seek efficiency gains to develop its "business";	Content analysis; Academic Literature Review
		What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?		

			• Municipality of Eindhoven: improvement of safety; branding; • Philips: need a real-life setting to experiment with its technology; implement its technology in the street; • Companies (Atos, Bosch, VNotion, Munisens, Geodan, Coosto, Vodafone, Het Lux Lab): learn from the real-life experience; **Enablers**: they bring tools, knowledge and methods for research; • Organizations (DITSS and CrimiNee!): offer expertise in security issues; • Polyground: intermediary between police, residents, pub owners and municipality; **Users**: • Visitors: observed in their use of space; • Residents: bring knowledge and feedback; • Pub owners: offer knowledge and feedback and offer practical experience; **Researchers**: research on technical topics related to the focus of the ULL, or policy and business research; • Eindhoven University of Technology (TU/e), Intelligent Lighting Institute (ILI), Fontys University of Applied Sciences: experimentation in the area using their resources; analysis of results and creation of new knowledge; • Tilburg University: brings knowledge on legal issues, such as privacy regulation; **Producers**: all actors actively join contributing with knowledge and time.	
	3.2. Development of Innovation (exploration)	SEE 2.1	• First time Philips is conducting research about use of light focusing the use of colours and the ability to influence mood and stress levels of visitors in public spaces; • New skills required from data scientists to analyse data of different nature and combine patterns to create new insights.	Content analysis; Academic Literature Review

	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	• Intervention in the street: experimentation with colours and intensity of light; experimentation with scents; design of the terraces; • Instantaneous data collection via sensors and other systems concerning the behaviour of the users of the streets; • Data collected with delay: posts on social media, police reports on incidents, determination of origin and counting of mobile devices, litres of beverage consumed, amount of waste produced; • Integration of all information collected to learn how to improve the liveability in the street and also to draw more general lessons of how data can be used to improve liveability in urban areas.	Content analysis; Academic Literature Review
	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	• Correlating the data on incidents to specific parameters is done to predict when there is a higher risk for escalation. Historical data from past incidents is used to find such correlations. Based on the determined risk level, lighting scenarios are activated. New data is produced and the effectiveness of the method is analysed.	Content analysis; Academic Literature Review
4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	• Citizens: visitors and residents; • Knowledge institutions: Eindhoven University of Technology (TU/e); Intelligent Lighting Institute (ILI); Fontys University of Applied Sciences; Tilburg University; • Organizations: Dutch Institute for Technology Security and Safety (DITSS); CrimiNee!; Polyground; • Private sector: business and property owners; entrepreneurs; Eindhoven 365; • Companies (technology producers): Atos; Philips; Bosch; VNotion; Munisens; Tele-Event; Geodan; Coosto; Vodafone; Het Lux Lab; • Public sector: Provincial Government of Brabant; Municipality of Eindhoven; Dutch Institute for Technology, Safety and Security (DITSS); Ministry of Security and Justice; Netherlands Organization for Scientific Research (NWO); Brainport Region; Police.	Content analysis; Academic Literature Review
		How many participants are involved in total (per group)?	• More than 20 research institutions and other interested parties; • 10,000 – 15,000 visitors in the street per week.	Content analysis; Academic Literature Review

	4.2. User centred	Are the citizens actively participating in all the stages of the processes taking place in the ULL?	• The citizens are listed as stakeholders in the project manager's list of partners; • They actively participate adding practical knowledge about the pre- and post- intervention situation.	Content analysis; Academic Literature Review
	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	• The municipality has the largest responsibility for the ULL.	Content analysis; Academic Literature Review
5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	• Stratumseind 2.0 is located in the Stratumseind street itself, in the inner-city nightlife entertainment area of Eindhoven; • It is a pedestrian street approximately 400 metres long, with around 50 pubs; • The Centre of the ULL is physically house in the Old Court of the Stratumseind street. On the first floor are some monitors, computers and laptops where all data is gathered; • Sensors and cameras are placed along the street.	Observation; Content analysis; Academic Literature Review
	5.2. Real-life Setting	SEE 5.1	• Data collected in real-time and other influential data such as weather, noise, numbers of visitors, posts on social media and occupancy rate of parking garage are analysed together to generate new knowledge to be used to improve the liveability, attractiveness and safety in the street; • Data is proceeded to percentages to ensure the anonymity of users.	Observation; Content analysis; Academic Literature Review
	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	The municipality financed about 50% of the project because the ULL: • Directly contributes to make the street more viable; • Fits in the political agenda in the field of security and safety; • Can be used to promote the image of Eindhoven as Smart City.	Content analysis; Academic Literature Review

		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	• The residents and visitors can be empowered by the initiative, since they can see how much noise is produced during the night and during events; • Once the street is under monitoring, the organizers of events tend to better stick to the rules and the visitors get some more responsibility; • Increasing the safety and liveability in the street means to empower visitors and residents; • The project allows the municipality to contribute to community building; • Citizens get opportunity to use the data available.	Content analysis; Academic Literature Review
	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	• Four years, from 2014 to 2018; • Uncertain continuity of the project after 2018.	Content analysis; Academic Literature Review

Source: Brainport Eindhoven (n.d.), Brainport Eindhoven (2017), Den Ouden, Valkenburg, et al. (2014), Den Ouden, Valkenburg, et al. (2016), Meijer and Thaens (2016), Ruijsink and Smith (2016), Ruijsink (2017), SmartData City (n.d.), Snijders, (2016), TU/e (2017a), TU/e (2017b) Van de Nieuwenhof, J. (2015), Verschuren, C. (2014) with modification by author (2017).

Table 24: ZOHO Analysis

CASE 2a				
Name	ZOHO			
Focus	Transition-driven			
Analysis				
Variables	**Characteristics**	**Questions**	**Explanation**	**Data Sources**
1. Profile	*1.1. When*	When did the ULL start?	• 2013	Interview; Content analysis; Academic Literature Review
	1.2. How	How did the ULL start?	• Havensteder bought few buildings in the edge of Rotterdam's centre; • Decision for the gradual development of the area instead of demolishing the vacant buildings.	Interview; Content analysis; Academic Literature Review
	1.3. Where	Where the ULL is located?	• Rotterdam, The Netherlands.	Interview; Observation; Content analysis; Academic Literature Review
	1.4. Why	Why did the ULL start?	• To transform the deprived business quarter Zomerhofkwartier (ZOHO) into a vibrant mixed-use area; • To learn about new ways of development; • To increase the climate change resilience in this vulnerable area.	Interview; Content analysis; Academic Literature Review
	1.5. Initiator	From whom did the initiative start?	• Havensteder (with collaboration of STIPO)	Interview; Content analysis; Academic Literature Review

2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	• The main goal of ZOHO as ULL is to transform a stagnated area of Rotterdam into a vibrant neighbourhood, creating a new and unexpected extension of the city centre; • To innovate and recreate new local and global networks by recruiting and selecting new entrepreneurs; • To be an urban laboratory where promising climate measures are combined with the urban transition and its local initiatives.	Interview; Content analysis; Academic Literature Review
		Does the ULL have more than one project? What are the guidelines to select a new project to start?	• Several projects are included as part of ZOHO's development.	Interview; Content analysis; Academic Literature Review
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	• Innovation with urban development planning, since it was adopted a "slow urbanism" model; • Networking development between local partners, combining top-down and bottom-up approach.	Interview; Content analysis; Academic Literature Review
	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	There are strong partners in and around the area: • Existing companies; education institutions; businesses located in the area and surroundings.	Interview; Content analysis; Academic Literature Review
	2.3. Local sustainability innovations	How does the ULL contribute to sustainable urban development, if at all?	• Value creation for private sector and residents of the area; • More vibrant, safe and alive public spaces; • Enhanced security and increased employment; • Test site for rainproof public spaces.	Interview; Content analysis; Academic Literature Review
3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized?	**Enablers**: they bring tools, knowledge and methods for research;	Interview; Content analysis;

		What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?	• **Enabler-driven: network forms around a region (regional development) or a funded project (e.g. public funding);** • Havensteder: selection of partners and users for the building, provision of security to tenants and investors; • STIPO; development of slow urbanism development plan; organizer and programmer of activities; • ZOHOCitizens: representative of the interests of ZOHO participants when negotiating with other partners, they bring money and/or time; • Ministry of the Interior and Kingdom Relations: enable experimentation with regulation; • Municipality of Rotterdam: smoothly as possible with the application of laws and regulations; **Providers**: they offer infrastructure, financial support and other necessary resource; • Havensteder: major local landlord; • Municipality of Rotterdam: funding for interventions in public spaces; facilitator by switching off regulations to enable specific interventions; • Tenants: intervention in the ground floor area, to implement a public function; • European Commission: European Union's LIFE funding programme; **Utilizers**: they seek efficiency gains to develop its "business"; • Havensteder: local development and value creation; • Municipality of Rotterdam: regulation experiment; implementation of climate change resilience plan; • Companies and entrepreneurs: work together to promote new activities and projects; committed to invest money and time to enhance innovative projects and a strong network; **Users**: • Visitors: testers of the activities; • Residents: testers of the activities, participation in the interventions; **Researchers**: research on technical topics related to the focus of the ULL, or policy and business research; • Students: execute tasks for parties away and work to strengthen the relationship between the area and its surroundings; • STIPO; development of slow urbanism development plan; organizer and programmer of activities;	Academic Literature Review

			Producers: all actors actively join contributing with knowledge and time.	
	3.2. Development of Innovation (exploration)	SEE 2.1	• Play with different scales of intervention, such as property, neighbourhood and city; • Inclusion of existing institutes/practices into a new way of thinking and doing – to link physical, social and economic developments; • It works as a showcase for the parties and as a place to experiment, including with new business models.	Interview; Content analysis; Academic Literature Review
	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	• Process around three integrated premises: connect, create and learn. Connect: • Selection of new tenants for the building through pitches, attracting actors who agree with the principles that guides ZOHO's development; • Inclusion of existing partners in the area to create a network around the ULL. Create: • Experimentation with new business models, places, activities and services. Learn: • Learning from practical experience acquired in projects from inside and outside the ULL ecosystem.	Interview; Content analysis; Academic Literature Review
	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	• One of the goals ZOHO is to learn of other ways of development, by trial and error.	Interview; Content analysis; Academic Literature Review

4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	• Citizens: visitors, residents, neighbourhood organisations; • Knowledge institutions: two University courses placed inside one of the ZOHO's building; • Private sector: business owners and entrepreneurs; De Urbanisten; Havensteder; STIPO; • Organization: ZOHOCitizens; • Public sector: Municipality of Rotterdam; Ministry of Interior and Kingdom Relations; Schieland and Krimpenerwaard Higher Water Board (in Dutch: *Hoogheemraadschap Schieland and Krimpenerwaard*); European Commission, Ministry of Housing.	Interview; Content analysis; Academic Literature Review
		How many participants are involved in total (per group)?	• 100 tenants.	Content analysis; Academic Literature Review
	4.2. User centred	Are the citizens actively participating in all the stages of the processes taking place in the ULL?	• The users of the area, companies, organizations, inhabitants and visitors can get involved with the development plans; • Active residents from the neighbourhood are governed by activities in ZOHO; • Use of placemaking activating community to create ownership over public space.	Interview; Content analysis; Academic Literature Review
	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	• The spot in the buildings is offered by Havensteder and STIPO, who select the companies through pitches: this way they ensure a good mix of participants that will produce value for the area; • The partners contribute with their own knowledge and expertise, generating a lot of commitment and energy in the ULL.	Interview; Content analysis; Academic Literature Review
5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	• The ULL takes place in the former business area named Zomerhofkwartier, sandwiched between Bokelweg, the Hofbogen, the Teilingerstraat and the Noordsingel, covering 5 hectares and 25,000m² of floor surface; • Near Rotterdam Centraal Station and inner-city centre; • It includes outdoor areas (green, seating areas, lighting, streets, skirting boards, and public facades) and buildings (*Het Gebouw*, *Het Gele Gebouw*, *Katshoek* and *Hofbogen*).	Interview; Observation; Content analysis; Academic Literature Review

	5.2. Real-life Setting	SEE 5.1	• Construction of projects part of the climate change resilience plan: Benthemplein water plaza; rain garden; underground infiltration system under Ammersooiplein; *depaving* strategy: increase in green areas and reduction of areas with pavement; • Landscaping of green courtyard gardens and green rooftops.	Interview; Observation; Content analysis; Academic Literature Review
	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	• The interventions are supported by the Local Government through funding and flexibility of regulations; • The local urban projects are part of "Rotterdam Adaptation Strategy", released in 2003.	Interview; Content analysis; Academic Literature Review
		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	The residents can better address their needs in two scales: <u>Neighbourhood scale</u>: • Improvement in safety, vibrancy and quality of the public areas; diversity of business; community-led interventions; • Social enterprises and the neighbourhood coop to involve residents and bring people from a situation of unemployment to a day structure and eventually jobs; <u>City scale</u>: • Local residents and students, coordinated by the urban planners, designed the climate-adaptive "rain garden" built along the Hofplein line.	Interview; Content analysis; Academic Literature Review
	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	• There is room for trying, from long rental periods to temporary events; • 10-year long development, from 2013 to 2023.	Interview; Content analysis; Academic Literature Review

Source: Both, P. (2016), De Jong, A. (2014), De Urbanisten (2017), Havensteder (2017), Het Gele Gebouw (2017a), Het Gele Gebouw (2017b), KATSHOEK (2017), Lofvers and Devos (2015), Maclean, B. (2015), Snoek, L. (2015), re:Kreators (2017)Rotterdam Climate Initiative (2017), STIPO (2017), Tillie and van der Heijden (2016), van der Kleij, G., et al (2017), van den Heiligenberg, Heimeriks, et al. (2017), ZH Expert (2017), ZOHO (2017a), ZOHO (2017b), ZOHO (2017d), ZOHO (2017e) with modification by author (2017).

Table 25: Living Lab Circular Buiksloterham Analysis

CASE 2b				
Name	Living Lab Circular Buiksloterham			
Focus	Transition-driven			
Analysis				
Variables	**Characteristics**	**Questions**	**Explanation**	**Data Sources**
1. Profile	*1.1. When*	When did the ULL start?	• The ULL started in 2015 when the Manifesto Buiksloterham was signed, however since 2006 the area was targeted by the Municipality.	Interview; Content analysis; Academic Literature Review
	1.2. How	How did the ULL start?	• In 2006, the municipal council accepted the investment plan for Buiksloterham (in Dutch: *Investeringsbesluit Buiksloterham*); • An organic development was adopted as practical solution to overcome the stagnation caused by the national economic recession of 2008; • Since then, the municipality changed the zoning and promoted tenders to selected new uses for the area.	Interview; Content analysis; Academic Literature Review
	1.3. Where	Where the ULL is located?	• Amsterdam, The Netherlands	Interview; Observation; Content analysis; Academic Literature Review
	1.4. Why	Why did the ULL start?	• An inner-city former industrial and even polluted area was left undeveloped for long time; • Part of wider restructuring of the Northern IJ-Banks in Amsterdam; • Need for circular cities; • Self-construction to overcome the credit crisis.	Interview; Content analysis; Academic Literature Review
	1.5. Initiator	From whom did the initiative start?	• Municipality of Amsterdam	Interview; Content analysis;

				Academic Literature Review
2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	• To transform Buiksloterham into a sustainable and circular district, combining the industrial location with housing and offices, with the collaboration of citizens, entrepreneurs, city government and other public organizations.	Interview; Content analysis; Academic Literature Review
		Does the ULL have more than one project? What are the guidelines to select a new project to start?	• Several projects ranging from many small projects and innovations, with good communication between them, to big pieces of land to be redeveloped; • There is a smart selection of new small projects and initiatives due to limited means, time, money and capabilities to implement them in practice; • The circular ambitions indicated by the municipality are linked to five themes: energy-neutral construction; raw materials; construction procedure; climate adaptation; sustainable mobility.	Interview; Content analysis; Academic Literature Review
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	• Introduction of better regulations for new-build homes; • Economy of resources: water and energy; • Smart waste collection technology and recycling of (building) materials; • Development of knowledge about circular economy.	Interview; Content analysis; Academic Literature Review
	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	• Focused on local exchanges rather than large networks. CityLab Buiksloterham enhance the communication between different parties by organising table sessions related to different themes, like energy, water and waste; • Professional workshops in the field of culture, organizational development and design and sustainability at De Ceuvel; • Subsidies, loans and donations were crucial for the feasibility of some initiatives; • National and international renown.	Interview; Content analysis; Academic Literature Review

	2.3. Local sustainability innovations	How does the ULL contribute to sustainable urban development, if at all?	• Transformation of a former industrial and polluted site into a sustainable mixed-use urban area; • Implementation of integrated sustainable techniques such as renewable power, rainwater harvesting and recycling; • Development of new models for production, consumption, distribution and logistics; shifting from ownership to usership (sharing economy).	Interview; Content analysis; Academic Literature Review
3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized? What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?	**Enablers**: they bring tools, knowledge and methods for research; • **Enabler-driven: network forms around a region (regional development) or a funded project (e.g. public funding);** • Municipality of Amsterdam: facilitate and support the development of the neighbourhood, in an experimental way; establishment of a guiding framework; • Ceuvel Association: design the urban development, infrastructural and landscape plan; • Metabolic, Studioninedots and DELVA Landscape Architects: vision of Buiksloterham. • CityLab Buiksloterham: enhance the communication between different parties; • Waterloft and Space&Matter: consultants; • Volunteers and professionals: organizing professional workshops; • Schoonschip Foundation: CPO development; **Providers**: they offer infrastructure, financial support and other necessary resource; • Municipality of Amsterdam: sustainability fund, investments in the public area and infrastructure; • Tenants and self-builders: source of investments; • Entrepreneurs: source of resources. **Utilizers**: they seek efficiency gains to develop its "business"; • Municipality of Amsterdam: development of a stagnated and polluted district of the city; • Companies: gaining experience with the installation of a local experimental technologies. • Entrepreneurs: they have a room for experimentation. **Users**:	Interview; Content analysis; Academic Literature Review

			• Self-builders: They build their own houses following some regulations; • Visitors: testers of the activities; • Residents: management of public area and programming. **Researchers**: research on technical topics related to the focus of the ULL, or policy and business research; • AMS Institute: production of knowledge in relation to the circular city concept; • TNO, Wageningen University, Deltares and Energy Research Centre of the Netherlands (ECN): working together in the ULL, to develop innovative solutions. **Producers**: all actors actively join contributing with knowledge and time.	
	3.2. Development of Innovation (exploration)	SEE 2.1	• Test with interactive governance, working within the legal constraints and the zoning plan; • Topics like circularity and sustainable techniques are also target of exploration activity.	Interview; Content analysis; Academic Literature Review
	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	• Experimental way of working, starting from practice by trying out, involving various actors and developing solutions that truly work; • More organic approach opted by the municipality: changes in the zoning and regulations; • Collaborative process; • Individual private development starts with allocation of plots, selection of candidates followed by individual development; • Meetups between developers and future residents to stimulate both social contacts and knowledge exchange in terms of circular building.	Interview; Content analysis; Academic Literature Review
	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	• There is an intention to use the ULL to assess the impact of innovations on residents and external safety before the technologies can be used in other neighbourhoods; • A monitoring and measuring system analyses the different flows of energy and materials in De Ceuvel; • Since hardly anyone is already living on the self-constructed plots and there is currently no coherent	Interview; Content analysis; Academic Literature Review

			monitoring plan, it is difficult to evaluate specific sustainability performances.	
4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	• Citizens: self-builders; citizens; tenants; volunteers; individual visitors; • Knowledge institutions: Amsterdam Institute for Advanced Metropolitan Solutions; Pakhuis de Zwijger; TNO; Wageningen University and Research; Deltares; ECN; • Private sector: Entrepreneurs; Developers (Hurks, Amvest); Housing Cooperations (Eigen Haard, De Alliantie, Ymere); Studioninedots; Metabolic; DELVA Landscape Architects; Space&Matter; Waterloft; • Organizations: ANGSAW; SPINN; Platform van der Pek and Distelbuurt; Citylab Buiksloterham; VEBAN; Stichting Schoonschip; Ceuvel Association; • Companies: WaterNet; New Energy Docks; NUON; Westpoort Warmte; Waterschap Amstel, Gooi en Vecht; • Public sector: Municipality of Amsterdam; National Government of The Netherlands; Province of Noord-Holland; Project Management Agency Noordwaarts; Amsterdam Council for Urban Development; *Afval Energie Bedrijf* Amsterdam; Amsterdam Economic Board.	Interview; Content analysis; Academic Literature Review
		How many participants are involved in total (per group)?	• 24 parties signed the Buiksloterham Manifest; • 50-100 people actively contributing to the maintenance and management of De Ceuvel; • Number of residents in 2013: 252; • Expected number of residents in 2030: 6.429.	Interview; Content analysis; Academic Literature Review
	4.2. User centred	Are the citizens actively participating in all the stages of the processes taking place in the ULL?	• The citizens have freedom to self-build their homes; • In the Schoonschip CPO the inhabitants are closely involved in from the start; • User and local volunteers re involved in the construction process contributed to the building of a community.	Interview; Content analysis; Academic Literature Review

	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	• Manifesto Buiksloterham: informal agreement of cooperation between parties; • The citizens interested in self-build their houses must present a compulsory form provided by the municipality; • Municipality allows experimentation and flexibility however there are still regulations to promote circularity and sustainability, being these criteria used when grating building plots.	Interview; Content analysis; Academic Literature Review
5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	• Buiksloterham is a brown-filed of 100 ha (net plan area consists of 52ha) with some active industrial activity, located just a short ferry from the city centre, in the Northern bank of IJ River; • Amsterdam's most polluted industrial site; • De Ceuvel: 0.45ha - 25 businesses in 16 houseboats (café, studio, workplaces, workshop, meeting room); • Schoonschip: 0.85ha – 46 residences in 30 boats; • Self-build houses: 2.3ha (approx.. 66 plots); • Cityplot: 2.8ha (living, business space and catering sector).	Interview; Observation; Content analysis; Academic Literature Review
	5.2. Real-life Setting	SEE 5.1	• The City of Amsterdam is facilitating and supporting the development of Buiksloterham into a sustainable and circular district; • Self-builders, people that are building their own houses, are invited to contribute; • Temporary character of De Ceuvel with lasting effect due to the attraction of visitors and knowledge production.	Interview; Observation; Content analysis; Academic Literature Review

	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	• The development of Buiksloterham was released by the municipal council as a municipal plan in 2006: *Investeringsbesluit Buiksloterham: Transformatie naar stedelijk wonen en werken*; • Investments of €157 million, while the total projected income from ground lease was €141 million; • The Municipality is making use of several instruments to contribute to the implementation of the Buiksloterham as a circular and sustainable district: tenders, land allocation and selection of self-builders, design of rules of development and zoning plan, provision of free guidance and intervention in the public space; • Funding for projects that lead to sustainability.	Interview; Content analysis; Academic Literature Review
		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	• More relaxed regulations to allow experimentation; • Participation in the decision-making process regarding the community as a whole; • Creation of civic organizations to manage the projects; • Self-built houses.	Interview; Content analysis; Academic Literature Review
	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	• Timeline for the neighbourhood development: from 2005 to 2030; • De Ceuvel: ten years lease of the polluted site, from 2012 to 2022; • Schoonschip: construction phase between 2016 to 2019; • Self-builders: average time to design and construct a house of 3 years, however they follow an individual speed.	Interview; Content analysis; Academic Literature Review

Source: AMS Institute (2015), AMS Institute (2017), Amsterdam Smart City (2017), Amsterdam Smarty City (2016b), CB Expert (2017), Delva, Wijnakker, et al (2016), Geemente Amsterdam (2017), Geemente Amsterdam (n.d.), Gladek, et al (2015), Lokman (2017), Potjer and Hajer (2017), Prendeville, et al (2017), Reimerink, L. (2016), Savini and Dembski (2016), Shilder (2016) and Steen and Van Bueren (2017) with modification by author (2017).

Table 26: Living Lab Habitat Analysis

CASE 3a				
Name	Living Lab Habitat			
Focus	Citizen-driven			
Analysis				
Variables	**Characteristics**	**Questions**	**Explanation**	**Data Sources**
1. Profile	*1.1. When*	When did the ULL start?	• 2010	Interview; Content analysis; Academic Literature Review
	1.2. How	How did the ULL start?	• Result of a relationship between University, NGO Association *Ateliê de Ideias* and *Território do Bem* community; • Creation of a community development forum, named Bem Maior, where community leaders meet to discuss and propose solutions to their problems and demands.	Interview; Content analysis; Academic Literature Review
	1.3. Where	Where the ULL is located?	• Vitória, Espírito Santo, Brazil	Interview; Content analysis; Academic Literature Review
	1.4. Why	Why did the ULL start?	• In 2006, the community demanded knowledge in the areas of Civil Engineering and Architecture and Urbanism, resulting in the first project integrating this community of users and the academic community of the Federal University of Espírito Santo - UFES, through the courses of Architecture and Civil Engineering.	Interview; Content analysis; Academic Literature Review
	1.5. Initiator	From whom did the initiative start?	• Federal University of Espírito Santo + Community Território do Bem.	Interview; Content analysis; Academic Literature Review

2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	• To develop and apply environmental friendly technologies in collaboration with low income communities, improving the conditions of urban housing.	Interview; Content analysis; Academic Literature Review
		Does the ULL have more than one project? What are the guidelines to select a new project to start?	Focus on housing issue, not restricted to one technology, product or phase of a product life cycle. The technologies to be developed may be related to: • Any aspect of low-income housing issues and, therefore, must necessarily be focused on solutions with low maintenance and application costs; • Any aspect of the environment and the life in the countryside. Projects developed by Living Lab Habitat: • Connect Ideas: online platform to connect and mobilize residents, giving ideas on how to transform the community; • Housing, Manufacturing and Water: a programme to improve the quality of life in the community; • Meeting Brazil-Germany: a three days event to present projects for the urbanization of Território do Bem. • Bem Forte: improvement and strengthening of the local currency, implemented by the residents with cooperation of the NGO Association Ateliê de Ideias.	Interview; Content analysis; Academic Literature Review
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	• Clean technologies for construction of houses: soil-cement brick, architectural design that include principles of environmental sustainability and solar panels for water heating at low cost; • Search for new ways of living, the relationship with energy production and consumption, use and reuse of water and other resources; • The aim is not only to develop new technologies to the users, but to develop new users and new technologies at the same time; • Connect Ideas: an app, which is owned by the private sector partner; • Housing, Manufacturing and Water: new knowledge about social housing; • Meeting Brazil-Germany: a book named *Desafios da Habitação de Interesse Social: Território do Bem* (in English: Challenges of Social Housing, Território do Bem) • Bem Forte: proposals to improve the social currency.	Interview; Content analysis; Academic Literature Review

	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	• The actions are originated from the need of users who were able to explain, in a representative way, their interests. This interaction with final users in the development and experimentation of new technologies characterize the "open innovation" process; • The distribution and property of actives produced or acquired during the development of Living Lab Habitat is owned by all partners organizations of each project in the proportion of their participation (according to the Brazilian Law of Innovation).	Interview; Content analysis; Academic Literature Review
	2.3. Local sustainability innovations	How does the ULL contribute to sustainable urban development, if at all?	• Development of new technologies environment friendly for urban and rural housing aiming the sustainable development and the improvement of their quality of life; • Use of local workforce; • Knowledge production.	Interview; Content analysis; Academic Literature Review
3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized?	**Users**: • **User-driven: problem solving by collaborative accomplishments; network initiated be users lacks formal coordination mechanism;** • Community leaders: discuss and propose solutions to their problems and demands, giving shape to a strategic plan for specific projects; • Residents of Bem area: co-design solutions respecting local culture; • Urban and rural communities: organized in forums or other discussion spaces, allowing direct communication with them. **Providers**: they offer infrastructure, financial support and other necessary resource; • Federal University of Espírito Santo: coordinator of the project, steer their research in a multi-disciplinary approach to the housing issue in a real-life setting; • Donor Foundations: funding • FAPES: funding • Private sector: funding **Enablers**: they bring tools, knowledge and methods for research; • Municipality of Vitória: technical support;	Interview; Content analysis; Academic Literature Review

		What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?	• LabTAR: headquarter in production engineering department at UFES; management of the information flux of the interesting projects for LL-Habitat; host the Living Lab Habitat; • NGO Association Ateliê de Ideias: promotion of local development in Território do Bem; • Start-ups: development and management of intellectual property. **Researchers**: research on technical topics related to the focus of the ULL, or policy and business research; • University and research centres: knowledge production; • Post-graduate students: engagement in the Living Lab Habitat is a formal part of their curricular activities. **Producers**: all actors actively join contributing with knowledge and time and they must help to gather institutional, political and financial support.	
	3.2. Development of Innovation (exploration)	SEE 2.1	• Credit, technical assistance to the residents and construction of houses using clean technologies; • Social, education, research & development and continuing education projects organized as sub processes related to construction, energy, water and waste; • Management of innovation and knowledge.	Interview; Content analysis; Academic Literature Review
	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	• Organization of low-income communities in forums or other spaces of discussion that allow the identification of technological changes they require; • After identifying the needs and possible sources of funding, the participants (legal entity and individuals) from each organization that will participate in the project from its conception to writing, submission, acceptance, realization and accountability are contacted.	Interview; Content analysis; Academic Literature Review
	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	• Meetings between the community and the researchers from LabTAR; • Users explain their needs through their representatives.	Interview; Content analysis; Academic Literature Review

4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	• Citizens: Território do Bem residents; community leaders; cooperative Costumes Artes; Forum Bem Maior; Movimento Nacional de Luta pela Moradia; • Knowledge institutions: Federal University of Espírito Santo (UFES); Berlin University of Technology (TU Berlin); Federal Institute of Espírito Santo (IFES); LabTAR; Latec; Faculty Centro Leste; Municipal School of Fundamental Education Otto Ewald Júnior; Educational Center Charles Darwin; • Organizations: NGO Associação Ateliê de Ideias; Institute Renner; Sebrae; Ashoka; Inter American Foundation; Rummos Assessoria, Pesquisa e Avaliação; Institute Cooperforte; NGO Moradia e Cidadania; Institute HSBC; Foundation Anna Duus; Foundation Banco do Brasil; Children's International Summer Village; Group Nação; • Private sector: Institute of Technological Innovation; Prosperi; Unimed Vitória; ArcelorMittal Tubarão; Ahrrow; InterCement; Solvix Innovative Solutions; Siemens; Ágata Consultoria; Zaruc Tecnologia e Automação; Vale; Petrobrás; Summerhouse English Center; • Public sector: Foundation to Support to Research of Espirito Santo (FAPES); Bank Caixa Econômica Federal; Aderes; Ministry of Cities (Ministério das Cidades); National Secretary of Solidary Economy (Secretaria Nacional de Economia Solidária); Municipality of Cariacica; Municipality of Vitória; Portuguese Energy Institute; Foundation Otacílio Cozer; Health Unit Consoloção; State Secretary of Environmet (SEAMA).	Interview; Content analysis; Academic Literature Review
		How many participants are involved in total (per group)?		
	4.2. User centred	Are the citizens actively participating in all the stages of the processes taking place in the ULL?	• The residents are involved in the beginning of the process through the forums and other movements of discussion where residents can interact and to be involved with LL activities, from planning, evaluation and implementation of technologies; • The residents actively participate in the construction of the houses, generating income and employment; • The environmental education and the community participation are used in the technology development, respecting local culture and thus, contributing to the local development process.	Interview; Content analysis; Academic Literature Review
	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	• LabTAR is the main facilitator and it develops tools to ensure the dissemination of knowledge and training in project management of LL managers; • Living Lab Habitat choose the communities through their representative movements to work within Forum Bem Maior.	Interview; Content analysis; Academic Literature Review

5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	• In a hilly region of Vitória city called Teritório do Bem, with around 31,000 inhabitants divided in 8 smaller communities, the majority in a situation of economic, social and cultural, educational vulnerability; • In the context of Living Lab Habitat, the residents are represented by community leaders; • LabTAR is physically installed in UFES.	Interview; Content analysis; Academic Literature Review
	5.2. Real-life Setting	SEE 5.1	• Community-led bank *Banco Bem* granted loans to 135 families over a five-year period; • 10,000 people in a situation of social and economic vulnerability have been helped.	Interview; Content analysis; Academic Literature Review
	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	• The initiative is not officially supported by the local government; • Dependency of alternative sources of funding; • Adaptation of projects to funding opportunities or looking of specific funding opportunities for an aimed project;	Interview; Content analysis; Academic Literature Review
		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	• At the broader level, the engagement of the local community in the forums empowers citizens to define the actions to be taken in the neighborhood, with a direct impact on their prospects for the future; • Keeping the community at the center of technology development, achieved through a mixture of environmental education and community engagement, ensures that the co-designed solutions respect local culture, rely on low-cost technologies, and promote sustainable development; • Forum Bem Maior: community leaders meeting to discuss and to propose solutions to their problems and demands; • Banco Bem: community-led bank where residents are responsible to elaborate the politic and social control of the bank.	Interview; Content analysis; Academic Literature Review
	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	• The projects last in average between 1 and 2 years.	Interview; Content analysis; Academic Literature Review

Source: Da Silva (2012), ENoLL (n.d.), Eskelinen, Robles, et al (2015), Habitat Living Lab (2009a), Habitat Living Lab (2009b), Habitat Living Lab (2009c), Habitat Living Lab (2009d), Habitat Living Lab (2009e), LLH (2017), LabTAR (2016b), LabTAR (2013a), LabTAR (2013b), LabTAR (2013c), LabTAR (2013d), LabTAR (2013e), LabTAR (2013f) Mol, Macal, et al (2014), Pinto (2009), with modification by author (2017).

Table 27: Vrijburcht Community Analysis

CASE 3b				
Name	Vrijburcht Community			
Focus	Citizen-driven			
Analysis				
Variables	**Characteristics**	**Questions**	**Explanation**	**Data Sources**
1. Profile	*1.1. When*	When did the ULL start?	• Establishment of Vrijburcht Stichting: between 2000 and 2003; • Finish of construction: 2007.	Interview; Content analysis; Academic Literature Review
	1.2. How	How did the ULL start?	• In 2000, the Municipality of Amsterdam launched an open call for development of visionary housing projects in IJburg district, using the opportunity to experiment with new forms of urbanization, including self-built and collective housing scheme; • Several families joined in a group and drew up a proposal that brings together key concept of a collective project. Their idea was selected by the municipality alongside 27 initiatives.	Interview; Content analysis; Academic Literature Review
	1.3. Where	Where the ULL is located?	• Amsterdam, The Netherlands	Interview; Observation; Content analysis; Academic Literature Review
	1.4. Why	Why did the ULL start?	• Mono-functional neighbourhoods and housing unaffordability in Amsterdam; • Municipality was looking for more self-sustaining, social and affordable housing.	Interview; Content analysis; Academic Literature Review
	1.5. Initiator	From whom did the initiative start?	• Municipality of Amsterdam (who invited the community to take change).	Interview; Content analysis;

				Academic Literature Review
2. Goal	*2.1. Urban Innovation*	What is the current main goal of this ULL?	• To develop a co-housing complex, below the market price and providing more flexibility for individual wishes, such as design choices and property ownership.	Interview; Content analysis; Academic Literature Review
		Does the ULL have more than one project? What are the guidelines to select a new project to start?	• The construction of the housing complex is the main accomplishment; • Creation of other parallel smaller projects (shared services and spaces) that make living and working conditions more attractive and stimulate social and cultural interaction.	Interview; Content analysis; Academic Literature Review
		Does this ULL develop new knowledge and products? If so, what kind of? For whom?	• Offer opportunities to families who wants to live in Amsterdam to find attractive urban housing for reasonable sizes and prices; • In a social and cultural sense, Vrijburcht contributes to raise the quality of life in the entire neighbourhood of IJburg; • Involve people in the design of their future dwellings in terms of layout, facilities and finishes.	Interview; Content analysis; Academic Literature Review
	2.2. Open knowledge development and innovation for application	Is there an open exchange of knowledge of the developed products and processes to achieve these products inside and outside the ULL ecosystem? With whom? How does it happen? What is the importance of it in your opinion?	• The inhabitants could meet each other within shared spaces and to connect with the surroundings; • Combination of indoor (theatre, cafe, glasshouse, workshop) and outdoor facilities (courtyard, small harbour); • Website that includes an internal platform for the community member to facilitate exchanges and communication; • Visits from other co-housing managers to learn from the experiences learned in Vrijburcht.	Interview; Content analysis; Academic Literature Review
	2.3. Local sustainability innovations	How does the ULL contribute to sustainable urban development, if at all?	• Construction of affordable housing in Amsterdam (below the market price), by building for the cost price; • Increasing of social cohesion and interaction within the neighbourhood; • Combination of living and working spaces with social and cultural activities supports local jobs and communication and it may inspire other initiatives; • High housing density with a mixed range of functions; • Sustainable materials were preferred during the construction process, with a focus on insulation, energy supply and community garden in the complex.	Interview; Content analysis; Academic Literature Review

3. Activities	*3.1. Co-creation*	What are the different roles performed by the participants? How are the rights and responsibilities shared? Is this made explicit and agreed by all? Is it formalized?	**User:** • **User-driven: problem solving by collaborative accomplishments; network initiated be users lacks formal coordination mechanism;** • Residents: financing their own houses, planning, design and participation in the construction phase; election of a board to represent them as a developer; • Vrijburcht Homeowner Association (*Vrijburcht Stichting*): non-profit foundation made up of project participants, acts as a client of architects, advisors and contractors during the development process; to monitor the finance process and to ensure that new members for the dwellings were recruited; to manage special shared spaces including: guest rooms, docks, hobby space, and garage; **Providers**: they offer infrastructure, financial support and other necessary resource. In this case, the providers offer financial security (helping to decrease the risks for the residents) instead of providing financial resources; • Municipality of Amsterdam: owner of the land and leasing agreement; • RABO Bank: Partly funded the preliminary phases and provided low interest mortgages to each family to cover construction costs; • De Key Housing Association (in Dutch: *Woonstichting*): contributed to pre-financing and offered to act as guarantor for dwellings left unsold, which turned out to be unnecessary, as all units were sold. Manager of various parts of the complex, including the assisted living, day-care and café, in view of the extensive regulations that apply to such businesses. **Enablers**: they bring tools, knowledge and methods for research; • Municipality of Amsterdam: provision of guidelines and set up of a team of experts to assist the residents group; • De Key Housing Association: management of the assisted living, day-care and café; • CASA Architects (Hein de Haan): social architect helped to translate the idea into an architectural design and a masterplan; • VLUGP Landscape Architecture: building the concepts and management of project; engagement in the decision board; • De Roef: assisted living space for six youth with slight mental impairments; • Theatre Foundation: responsible for operating and programming its stage. Moreover, various working groups, committees and volunteers organise activities. **Utilizers**: they seek efficiency gains to develop its "business";	Interview; Content analysis; Academic Literature Review
		What kind of resources any of the actors bring (e.g. knowledge, time, money, etc.) and how this is appreciated?	

			• Municipality of Amsterdam: to experiment with new forms of urbanization, including self-built and collective housing scheme; • De Roef: assisted living space for six youth with slight mental impairments. **Producers**: all actors actively join contributing with knowledge and time.	
	3.2. Development of Innovation (exploration)	SEE 2.1	• Vrijburcht is not a standard property development project but it is a group of families who consciously choose to live together and feel responsible for the success of the project; • Pioneering example of bottom-up, community-led housing project in Amsterdam; • Community self-organized group actively participate in realizing their own collective housing; • Affordability achieved because of the high housing density and operation without a real estate developing company.	Interview; Content analysis; Academic Literature Review
	3.3. Experimentation and Learning	Does your ULL make use of some kind of planning cycle (from idea to product); if so what kind of cycle? Who came up with this? How is this monitored and by whom?	• During the construction phase, the municipality set up a team of experts (in construction, urbanism, social housing, land lease, public space) to assist the group with monthly meetings to solve questions and discussion of ideas.	Interview; Content analysis; Academic Literature Review
	3.4. Interaction between activities of evaluation and learning	Is there gathering of feedback from the use and evaluation of processes and products after the implementation? If yes, how this information is processed, used and/or shared?	• Participatory process though committees to discuss specific topics and assemblies organized every two months with every participant, to make collective decisions.	Interview; Content analysis; Academic Literature Review
4. Participants	*4.1. Users, private actors, public actors and knowledge institutes*	Which societal groups do the participants of this ULL come from (citizens, private sector, public sector, knowledge institutions, NGOs…)?	• Citizens: Residents of Vrijburcht Community; • Organizations: Vrijburcht Stichting; De Roef; Theatre Foundation. • Private sector: RABO Bank; De Key Housing Association; VLUGP Landscape Architecture; CASA Architects; external professionals; • Public sector: Municipality of Amsterdam.	Interview; Content analysis; Academic Literature Review
		How many participants are involved in total (per group)?	• 52 dwellings;	Interview; Content analysis; Academic Literature Review

	4.2. User centred	Are the citizens actively participating in all the stages of the processes taking place in the ULL?	• Citizens were actively involved in all the decisions throughout the process, how to design the buildings, what materials should be used, which energy supplier should be contracted. They were represented by a board who acts as the formal client when receiving professional advice from the Municipality; • The inclusion of De Roef was voted by residents. • For instance, the courtyard design process was made by presentation, excursions, opinion polls and workshop until a common idea was formed: a lush green, natural and informal meeting space for all residents, young and old.	Interview; Content analysis; Academic Literature Review
	4.3. Decision power	Is the decision power equally divided between all the participant, including the citizens? Can you give examples on how this works in practice?	• Community structured around the Vrijburcht Stichting and its elected board, which has the responsibility to move the project forward. The Foundation decides on social and technical issues, but it doesn't have unlimited power; • All the members of the group of prospective residents and users had a vote in every decision. • To ensure the group of residents would arrive at an efficient process of collaborative decision-making, a minimal number of external professionals were hired at various stages of the process.	Interview; Content analysis; Academic Literature Review
5. Context	*5.1. Geographical Coverage*	Where does the activities of the ULL take place?	• The housing complex is located a waterfront location on the sheltered southern edge of Steigereiland, near the bicycle bridge to Diemerzeedijk; • Amsterdam's Central Station can be reached in 15 minutes by tram; • 52 dwellings (apartments, maisonettes and studios) with an average size of 100m²; • The complex also includes other services: commercial units, two guest rooms, a hobby space, daycare for 42 children, cafe with waterfront terrace, theatre, collective parking garage; greenhouse, courtyard garden, collective house for the young people of learning disabilities, docks for canoes and sailing club; • The land around Vrijburcht is public, including the swimming areas and the docks, which are leased from the government.	Interview; Observation; Content analysis; Academic Literature Review
	5.2. Real-life Setting	SEE 5.1	• Realization of tailored housing with 52 units; • 16 companies; • 40 people are employed in the complex.	Interview; Observation; Content analysis; Academic Literature Review

	5.3. Part of an Ecosystem	Is the ULL supported by the Local Government? Does it have an official status?	• In Amsterdam, social rented housing represents about 50% of the total housing stock and the Municipality owns 80% of the land. This situation facilitates the emergence of more social and alternative housing projects such as Vrijburcht; • The municipality offered the lease of the land for 50 years, however the land around Vrijburcht remains public; • Team of experts from the Municipality offered professional advice for the group of residents.	Interview; Content analysis; Academic Literature Review
		Does the ULL result in a situation in which local citizens have more power? Can they better address their needs? How? Why (not)?	• Demand-oriented development fits perfectly in the needs of the residents; • Since the Vrijburcht Community has been developed through a long and collaborative process, it entailed a strong sense of community between the residents; • Plans for selling house units should first be communicated with the residents of Vrijburcht. Any advertising should be linked to the project websites to inform potential buyers about the nature of Vrijburcht.	Interview; Content analysis; Academic Literature Review
	5.4. Time Focus	How long has the ULL been active? What is the average duration of a project?	• In 2002, a lease of 50 years for the site was given to Vrijburcht community; • Long-term creation project, between 2001 and 2007 (10 years since the occupation).	Interview; Content analysis; Academic Literature Review

Source: CASA Architecten (2005), CASA Architecten (2017), Changfang, L. (2015), CoHousing Culture (2017), Knoester, Miazzo, et al (2014), NAI (2017), Peborde, I. (2016b), Van Kouwen, S. (2016), VC Expert (2017), VLUGP (2017), Vrijburcht (2017a), Vrijburcht (2017b), Vrijburcht (2017c), UrbaMonde (2017), Wilkinson, G. (2015) (Mol, Macal, et al., 2014)(Mol, et al., 2014)(Mol, et al., 2014)(Mol, et al., 2014)(Mol, et al., 2014)(Mol, et al., 2014)(Mol, et al., 2014)with modification by author (2017).

Annex IV: Word Count

Table 28: Word count of the three types of ULL

Group	Word	Number of appearances		
		Technology-driven	Transition-driven	Citizen-driven
Technology-driven	innovation	942	-	-
	lab	632	-	-
	technology	591	-	-
	labs	526	-	-
	data	345	-	-
	technologies	275	-	-
	future	263	-	-
	system	252	-	-
	change	197	-	-
	used	188	-	-
	actors	183	-	-
	make	181	-	-
	create	180	-	-
	systems	179	-	-
	however	175	-	-
	case	162	-	-
	government	158	-	-
	study	144	-	-
	information	140	-	-
	innovative	123	-	-
Technology/Transition-driven	research	479	441	
	different	262	578	-
	use	231	490	-
	time	225	291	-
	knowledge	171	341	-
	based	170	217	-
Technology/Citizen-driven	living	1149	-	656
Citizen-driven	community	-	-	198
	work	-	-	195
	design	-	-	91
	construction	-	-	88
	residents	-	-	68
	together	-	-	66
	everyone	-	-	66
	key	-	-	45
Citizen/Transition-driven	city	-	1133	315
	local	-	419	130
	building	-	309	59
	social	-	248	344
	people	-	225	136
Transition-driven	urban	-	1824	-
	planning	-	873	-
	area	-	796	-

	water	-	558	-
	spatial	-	385	-
	municipality	-	340	-
	way	-	332	-
	approach	-	309	-
	public	-	279	-
	space	-	273	-
	areas	-	262	-
	many	-	261	-
	infrastructure	-	259	-
	like	-	240	-
	working	-	230	-
	environment	-	221	-
	quality	-	216	-
	level	-	209	-
	possible	-	192	-
All types	development	289	1288	209
	can	749	1090	282
	new	596	691	303
	process	376	662	196
	project	409	571	299
	one	203	340	73
	projects	239	326	319
	first	137	203	51

Source: Author (2017)

Annex V: Quantitative Analysis

Table 29: Criteria per type to be used when filling the quantitative analysis table

Variables	Characteristics	Description per type (1) Technology-driven (2) Transition-driven (3) Citizen-driven
Goal	*Urban Innovation*	(1) Development of new knowledge and products with strong technological approach. The network can use it as a branding opportunity.
		(2) Development of an alternative model of urban development to transition towards a more sustainable one.
		(3) To find solutions that solve a citizens' challenge.
	Open knowledge development and innovation for application	(1) Open exchange of the technological innovation.
		(2) Open exchange within a strong local network, with partners in and around the area.
		(3) Open exchange within the ULL's ecosystem and dissemination of knowledge and lessons learned with outside community. Attraction of people from other similar projects interested in the outcomes.
	Local sustainability innovations	(1) Projects are allies in the pursuit of urban sustainability by improving technologies.
		(2) Experimental implementation of urban development models based on long-term sustainability, such as climate proof and circular economy.
		(3) Largest impact in the social aspects of sustainability, such as social cohesion and interaction among the residents.
Activities	*Co-creation*	(1) Provider-driven.
		(2) Enabler-driven.
		(3) User-driven.
	Development of Innovation (exploration)	(1) Development of new products, services, uses and/or processes.
		(2) Development of new uses and/or processes, implemented in different scales of intervention (individual, local and regional).
		(3) Development of new products, services, uses and/or processes that help citizens to overcome their challenges.
	Experimentation and Learning	(1) Systematic and monitored planning cycle to guide experimentation.
		(2) Systematic planning cycle starts with the creation of a network, followed by experimentation and informal learning activity. The individual growth results in collective gains.
		(3) Informal planning cycle based on meetings between the citizens and other partners.
	Interaction between activities of evaluation and learning	(1) The data is collected during users' interaction with technology/space and is used to further develop the products.
		(2) Different ways for monitoring: collection of feedback based on the interaction of visitors and residents with the spaces; or use of a planned monitoring system to assess the efficiency in the use of sustainable technologies.
		(3) Informal activities of evaluation and learning.
Participants	*Users, private actors, public actors and knowledge institutes*	(1) Quadruple Helix actors are active contributors. The number of participants depend on the number of projects carried out in the ULL and their features.
		(2) Quadruple Helix actors are active contributors. The increase in the attractiveness of the area can result in the growth of the local network.
		(3) The users consist in the main group and their interests are safeguarded by the other actors.

	User centred	(1) Users are observed in their interaction with products/spaces, however they are less active as producers. The users can be either a person interested in the project or an independent visitor using the space.
		(2) Users participated through smaller bottom-up interventions.
		(3) Participatory process from the beginning throughout all the steps.
	Decision power	(1) Initiator (and main provider) has the bigger stake. All participants share a certain level of responsibility and decision power.
		(2) Initiator (and main enabler) has the bigger stake. All participants share a certain level of responsibility and decision power.
		(3) The users have a strong power in the decision-making process.
Context	*Geographical Coverage*	(1) The geographical coverage has very well demarcated boundaries.
		(2) The experimentation field covers a target area to be developed but can spread out from the original area to the surroundings.
		(3) The geographical coverage depends on the size of the community of users.
	Real-life Setting	(1) Enacted in a real-life context that varies from a lab setting to a public space.
		(2) Urban area with untapped potential for development.
		(3) Community of residents facing challenges in the urban setting.
	Part of an Ecosystem	(1) Part of the normal planning system covering smaller units of a city. Close involvement of the local government softening regulatory aspects.
		(2) Part of the formal planning system covering a large area under development. Experimental approach and more relaxed regulations helps to overcome implementation challenges.
		(3) The citizens must take charge of the project, even if it makes part of the formal planning systems, resulting in the community empowerment.
	Time Focus	(1) Short or long-term actions, with temporary character.
		(2) Long term urban development.
		(3) The dependency of external funding can either shrink or enlarge the time focus, depending on the self-sustaining capability of the initial group.

Source: Author (2017)

Table 30: Quantitative analysis

Characteristics		Technology-driven						Transition-driven						Citizen-driven					
		Case 1A			Case 1B			Case 2A			Case 2B			Case 3A			Case 3B		
		(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Goal	*Urban Innovation*																		
	Open knowledge development and innovation for application																		
	Local sustainability innovations																		
	Total	1	0	0,67	1	0,33	0,67	0	1	1	0,33	1	0,33	1	0,67	1	0	0,67	1
Activities	*Co-creation*																		
	Development of Innovation (exploration)																		
	Experimentation and Learning																		
	Interaction between activities of evaluation and learning																		
	Total	1	0,50	0,25	1	0,25	0	0	1	0,75	0,75	1	0,25	0,25	0,25	1	0	0,25	1
Participants	*Users, private actors, public actors and knowledge institutes*																		
	User centred																		
	Decision power																		
	Total	1	0	0	1	0,33	0	0,67	1	0,67	0,33	1	0,67	0,33	0,67	1		0,33	1
Context	*Geographical Coverage*																		
	Real-life Setting																		
	Part of an Ecosystem																		
	Time Focus																		
	Total	1	0	0	1	0,75	0	0,25	1	0,75	0,50	1	0	0,50	0,50	1	0,25	1	1
TOTAL		**4**	**0,50**	**0,92**	**4**	**1,67**	**0,67**	**0,92**	**4**	**3,17**	**1,92**	**4**	**1,25**	**2,08**	**2,09**	**4**	**0,25**	**2,25**	**4**

Source: Author (2017)

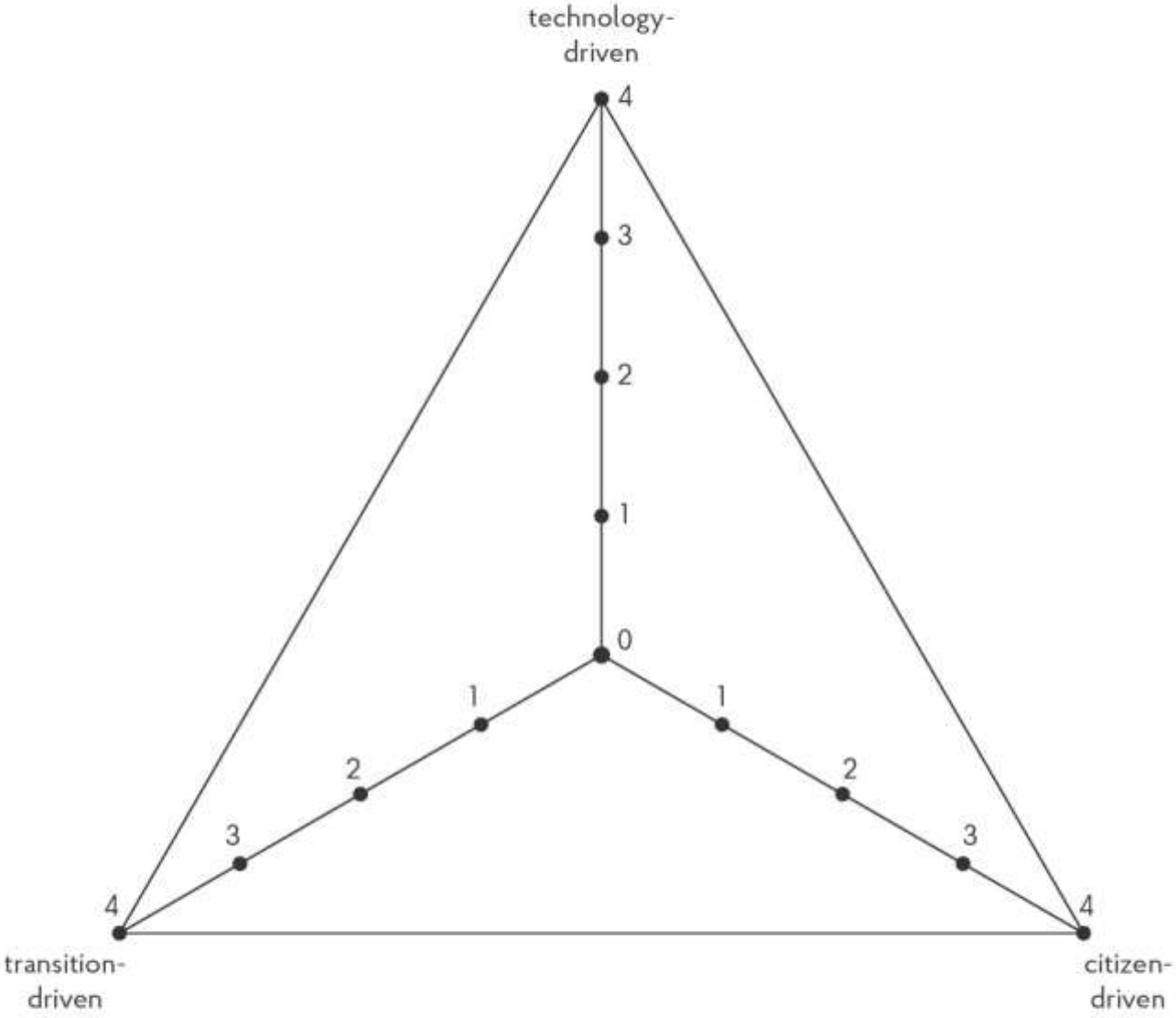
Annex VI: Templates for future researches

Table 31: Table template

Characteristics		CASE:			CASE:		
		(1)	(2)	(3)	(1)	(2)	(3)
Goal	*Urban Innovation*						
	Open knowledge development and innovation for application						
	Local sustainability innovations						
Activities	*Co-creation*						
	Development of Innovation (exploration)						
	Experimentation and Learning						
	Interaction between activities of evaluation and learning						
Participants	*Users, private actors, public actors and knowledge institutes*						
	User centred						
	Decision power						
Context	*Geographical Coverage*						
	Real-life Setting						
	Part of an Ecosystem						
	Time Focus						
TOTAL							

Source: Author (2017)

Figure 40: Graph template



Source: Author (2017)