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The living lab approach in the smart living innovation process

A multiple-case study

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Executive Summary

Our ageing population and decentralization in healthcare, puts pressure on municipalities in the Dutch society to reduce rising healthcare costs and look after their citizens. People are looking for solutions that enable elderly and disabled citizens to live in their homes for as long as possible and improve their quality of life. Technologies, also called smart living innovations, are used to support elderly in their daily lives and alleviate the burden of their informal caregivers. This requires a new way of innovating with focus on the user.

The concept of living labs has emerged as a new innovation approach to address societal issues such as an ageing population. Living labs can be seen as an environment or an innovation approach, of which the latter will be the scope of this research. It is a promising methodology that is insufficiently researched. Ståhlbröst (2009) identifies five principles of the living lab approach: openness, continuity, empowerment of user, realism and spontaneity. Three different living labs aimed at smart living innovations are being studied on how they practice the principles of the living lab approach. This research will identify the differences and similarities among cases and the effect on the living lab performance. In addition, the moderating effect of the network governance on the relationship between the living lab approach and the living lab performance will be added to this study. Additional research is needed on how to practice the living lab approach and to determine the contributions of this new innovation approach.

For this qualitative research, in-depth interviews with open questions are conducted with four or five different stakeholders per living lab. All stakeholders were from a different stakeholder group or 'helix' to gather a multitude of perspectives on how the living lab approach was practiced. Thereafter, a deductive coding technique was used, with codes found in the theoretical framework, to code the transcripts. However, it is important to maintain an open mind and don't force data into an aspect. This means some codes were added while coding the transcripts. These first order codes were addressed to the overarching codes, or second order codes: openness, continuity, empowerment of user, realism, spontaneity and network governance. With the first and second order codes a framework was established. Subsequently, the framework per case was filled in to determine how the living lab approach has been practiced in each case, based on a 1-5 Likert scale. After the living lab approach per case has been determined as cross-case comparison will be made and the impact on the performance of the living lab is determined.

This study shows how the principles impact the living lab performance and implicates how they should be practiced.

Openness has a positive impact on the effectiveness of the living lab innovation process, due to increasing knowledge and resources. However, no evidence was found that it also enhances the efficiency of the innovation process. Multiple perspectives could accelerate the innovation process, but involving too many stakeholders, delays decision-making processes. Living labs should be open and involve a high diversity of stakeholders, but not too many. Make sure that you involve the right people in the organization to increase efficiency in the process.

Continuity has a positive impact on the effectiveness and the efficiency of the living lab. Frequent interactions build trust and enhances knowledge sharing and commitment among stakeholders within the living lab which positively impacts co-creation and efficiency. In addition, it positively impacts the sustainability of a living lab when stakeholders frequently interact with each other. Living labs should organize sufficient meetings or interactions with stakeholders to facilitate co-creation.

Empowerment of the user positively impacts the effectiveness of the innovation process. By involving the users throughout the entire process the innovations better meet the needs of the user. However, high involvement of the user negatively impacts the efficiency of the innovation process due to research iterations and adjustments of research approaches to the target group. Living labs should empower the user but make a trade-off between the user's needs and other stakeholder's needs.

Realism can be practiced on multiple levels and increases the validity of findings, which positively impacts the effectiveness of the innovation process. However, it negatively impacts the efficiency of the innovation process due to loss of control during research and the moving around of expensive prototypes. Living labs should test in an environment that is as realistic as possible with a user group that represents the target group.

In this research it was hard to differentiate Spontaneity from the principle Empowerment of the user. The ability to detect, aggregate and analyse spontaneous user' reactions is not possible without the empowerment of the user. Therefore, the impact on the effectiveness of the innovation process was similar. Practicing spontaneity in a living lab increases the creativity, which positively impacts the effectiveness of the living lab because innovations better meet the needs of the user. Living labs should use a variety of research methods to increase validity and make sure that within focus groups, users are not dominated by other users.

This study added the moderator network governance, which turned out to impact the relationship between the living lab approach and the living lab performance. The governing party impacts the relationship, as well as the governance structures and mechanisms. Important living lab governance

mechanisms are: division of roles & responsibilities, management of expectations, goal consensus and involvement in decision-making processes.

Results show, that living labs are a useful methodology for finding solutions for societal problems such as an ageing population. To address a complex issue like this and aiming to find new products or services to support this, all principles of the living lab approach need to be practiced to great extend. The lower the practicing of the living lab approach principles, the more the 'living lab' appears to be a 'test facility' in which organizations are able to test or market their products. Living labs should be seen as an innovation approach and not just as a 'lab that lives' in which users test products in their home environments. In my opinion, one can call itself a 'living lab' when there is a user-driven co-creation process with multiple stakeholders in a real-life context to develop new products or services to address societal problems. In which especially the co-creation process is important and distinguishing from other innovation approaches.

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1 Introduction

1.1 Research topic

Municipalities in the Dutch society have to cope with several complex social issues such as climate change and social inequalities (Maas et al., 2017). Also healthcare is a big part of these social issues for municipalities due to the fact that since 2015 the Dutch healthcare sector has been decentralized which means that they are now responsible for among other the Social support act (WMO). This entails that they have the obligation to enable people to live in their own homes for as long as possible and improve their quality of live. This refers to people who are not self-reliant, such as the elderly or disabled (Rijksoverheid, 2015). Moreover, the Dutch population is ageing due to declining birth rates and increased life expectancy, which makes the challenge even bigger (Alam et al, 2012). Encouraging people to live at home longer will decline healthcare expenses and will increase their quality of life (Chan et al. 2008). However, this is challenging due to many aspects that need to be taken into account such as social exclusion and mobility (Keijzer-Boers et al. 2015). Healthcare providers acknowledge the added value of information- communication technology (ICT) and sensor networks connected to smart devices for elderly to support them living independently for as long as possible, and to cut costs in the healthcare domain. These solutions are called 'smart home' or 'smart living' solutions (Keijzer-Boers et al. 2015).

These solutions require new ways of organizing innovation initiatives such as living labs (Eriksson et al. 2005). Living labs is a new concept of managing innovation and is an increasingly used methodology. There are about 400 recognized living labs in Europe (ENoLL, 2016) and according to the Rathenau institute the Netherlands counts 90 living lab initiatives (Maas et al.2017). Although living labs have been defined in many different ways it has been agreed upon that they are open innovation ecosystems integrating research and innovation processes in a real life context, actively involving the end-user. According to Paskaleva et al. (2015) open innovation is 'a new paradigm for the Smart City where government and developers draw on the expertise, skills and knowledge of the citizens to co-produce urban services that are directly relevant to its citizens and their environment.' Living labs are a rather new concept and seem to be promising in solving complex societal issues. More research on the topic is needed to define them well and determine their added value (Maas et al., 2017).

1.2 Research question

Through a multiple case study, three different living labs facilitating smart living innovation initiatives will be compared. This research will look at the way in which the living lab approach is practiced in these cases, taking into account the perspectives form different stakeholders. In addition, this research will investigate the moderating effect of network governance on the relationship between the living lab approach and the living lab performance.

This leads to the following research question:

How should the key principles of the living approach be practiced in order to enhance the living lab performance, moderated by network governance?

In order to answer the research question, several sub questions need to be formulated and answered. First, it is important to clearly define the concept of smart living. Hence, the first sub question is:

What is smart living and what are smart living innovations?

Second, it is imperative to clearly define the concept of living labs and their characteristics. Important is the discrepancy between other innovation approaches and living labs. Hence, the second sub question is:

What are living labs and what are their main distinguishing characteristics?

After the literature review, a multiple-case study approach will be conducted. Subsequently it is important to look at how these distinguishing characteristics are practiced in the living labs and compare the cases to find similarities and differences.

Hence, the following sub questions are:

Which similarities can be found in the way the cases practice the living lab approach?

And

Which differences can be found in the way the cases practice the living lab approach?

1.3 Relevance

1.3.1 Research relevance

Living labs are an increasingly popular innovation approach that is suggested to be a promising, emerging area with a broad range of opportunities and benefits (Huizingh, 2011). Multiple researches call for more research on this methodology into understanding the living labs and their contributions better (Huizingh, 2011; Dekkers, 2011; Guzman, 2013). The Rathenau institute in the Netherlands calls for more research

on what is needed to effectively use living labs for social purposes and transitions (Maas et al. 2017). Due to our ageing population and changing legislation it is necessary that changes are being made in the Netherlands in order to enhance the quality of life of citizens. This research aims to how living labs can be used effectively in order to enhance the smart living innovation process in the Netherlands.

Ståhlbröst (2009) defined a set of five key principles to assess the impact of living labs. The principles of the living lab approach were defined after a single case study in the energy market. This research aims to elaborate on the literature of the living lab approach by comparing the approach among different cases and to look at the similarities and differences in how these principles are practiced. The living lab approach will be examined in another context: the smart living innovation context for elderly care. Additionally, the work of Ståhlbröst (2009) will be extended by exploring the moderating effect of network governance of the living lab on the relation between the living lab approach and living lab performance.

1.3.2 Managerial relevance

This research proposes practical implications for initiators of a living lab. An initiator of a living lab can be either a Dutch government agency, such as a municipality, an academic party or an organization. This study will help them determine whether this open innovation methodology is suitable for their desired outcome. Additionally, this study will give insights into how the living lab approach should be practiced and how the network of stakeholders within a living lab should be governed in order to accomplish a high living lab performance. The principles written in the literature are difficult to use as construction guidelines for living labs. For example, the principle Openness, in the literature is written: 'Living labs should be as open as possible.' This does not explain how the principle should be practiced. To successfully set up a living lab examples for the key principles are needed to learn from.

2 Theoretical Framework

In this chapter the theoretical background relevant for this research will be discussed. It is imperative to first define the concept 'smart living' and subsequently define each principle of the 'living lab approach' with its corresponding characteristics. In addition, performance metrics will be determined and the theoretical background of network governance will be discussed.

2.1 The Smart Living Domain

The scope of this research is smart living technologies. The focus will be on smart living innovations in the healthcare and social sector that will enable the ageing population to live in their homes as long as possible.

Smart living is a segment of Smart cities (appendix 1) and was formerly called Smart Home or Domotica (Solaimani et al, 2013). In smart cities traditional infrastructure is merged with ICT in order to enhance the equity, efficiency, sustainability and quality of life in cities (Batty et al. 2012).

A Smart Home is defined by Aldrich (2003) as:

> *"A Smart Home can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond."*

Smart living encompasses more than just Smart Homes and is more about the integration of smart solutions in everyday life; '*at home, along the way, or anywhere else*' (Keijzer-Broers, 2016). With the help of Smart Living technologies, health and social care institutions are able to provide a mean to sustain people within their own home, and therefore cut costs (Martin et al., 2008).

Due to increasing technologies, simple home automation systems are replaced by even more, advanced ICT-enabled services (Keijzer-Broers et al. 2013). There is a wide range of intelligent Smart Living services in the healthcare sector, such as assistive robots and sensor networks to smart devices, that support ageing-in-place. Different technologies such as artificial intelligence, robotics and mobile computing are key drivers of smart living initiatives (Solaimani et al. 2013).

With the help of aforementioned intelligent initiatives, elderly are able to receive care, save energy, guarantee their safety and support social communication and entertainment (Keijzer-Broers, 2016).

Apart from sustaining people within their own home, smart living technologies may enhance their quality of life and the life of their family and caregivers; the technologies can take a lot of work out off their hands. This is sometimes referred to as 'Ambient Assisted Living (AAL)' (Ni et al. 2015).

2.2 The Living lab approach

The concept of living labs builds on the previously written concepts in research. The first two cornerstones include von Hipple's (2008) work on user-driven innovation and Silverstone's (1993) work on the domestication of ICTs, which means 'to accustom to household life or affairs'; a theory about the understanding of the adoption and appropriation of ICT by users (Ballon et al. 2015). Another cornerstone is the concept of stigmery in which interactions and actions in communities of individuals are used to address complex problems which could lead to emergence of innovations (Pallot et al. 2010). The fourth, and last, cornerstone is the literature on open innovation which emphasizes the importance of collaboration between multiple stakeholders in today's innovation processes (Chessbrough, 2003). According to Bergvall-Kåreborn et al. (2009) the concept 'living lab' originates from Professor William Mitchell at MIT who used the term in 1995 to describe the observation of the living patterns of users in a smart living setting for a period of time. The concept of living labs has been discussed in the literature in very different ways, which sometimes makes it hard to understand what a 'living lab' exactly means (Brankaert, 2016).

There is not a shared or common definition of Living labs in the academic literature but they share common elements (Maas et al. 2017).

Definition	Source	Elements
'Living labs can be defined as physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes, and users that collaborate to create, prototype, validate, and test new technologies, services, products and systems in real-life context'.	Westerlund & Leminen (2011)	• Multi-stakeholder • Real-life context • 4Ps
'A living lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values.'	Bergvall-Kåreborn et al.(2009)	• User-driven • Open innovation • Multi-stakeholder • Real-life context • Sustainable values

'A user-driven open innovation ecosystem based on business-citizens-government partnerships which enables users to take active part in the research, development and innovation process.'	European Commission (2009)	• User-driven • Open innovation • Multi-stakeholder
'A user driven, open innovation environment in real-life settings in which users test and experiment new products or services, in a framework integrating companies, people, research and innovation actors and public sector (the so called public-private-people partnerships, PPPP).'	Alcotra innovation document (2010)	• User-driven • Open innovation • Real-life context • Multi-stakeholder • 4Ps
'Open innovation environment in real-life settings in which user-driven innovation is the co-creation process for new services, products and societal infrastructures.'	ENoLL	• Open innovation • Real-life setting • User-driven • Co-creation

Table 1: Living lab definitions from literature

Summarizing the findings above there are some basic elements that are reflected in multiple researches. These elements are open innovation, real-life context, multi-stakeholder and user-driven innovation. Living labs can be either seen as a milieu (environment, arena) or as an approach (methodology, innovation approach). The living lab as approach will not focus on only the environment and takes a broader, more holistic perspective (Welfens et al. 2010). This will be the focus of this study.

According to Ståhlbröst (2009), the living lab approach consists of 5 key principles that living labs should practice in order to attain their goals: Openness, Empowerment of users, Realism, Continuity, Spontaneity. Where open innovation could be linked to 'openness', real-life context to 'realism', multi-stakeholder to 'openness' and user-driven innovation to 'empowerment of users'. The principles of the living lab approach will be discussed below.

2.2.1 Openness

In closed innovation, a company primarily relies on its own knowledge and resources when developing new products, services or reaching new markets (Gassmann, 2006). In the open innovation literature

'openness' refers to companies opening up their innovation process on the development of new products and services to institutions outside their organization. The term open innovation was first introduced by Chesbrough (2006) as:

> "*The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology.*"

There are many different forms and trade-offs between open innovation approaches (Schuurman et al. 2016). A living lab is an open innovation ecosystem in which companies open up their innovation processes to the end-user (Schuurman et al. 2013). It is essential for Living labs to maintain an open innovation approach in order to gather a multitude of perspectives that will lead to the generation of novel ideas and a more successful development (Bergvall-Kåreborn et al. 2009). The difference between the living lab approach and other forms of open innovation is that living labs are more business to consumer while open innovation usually is business to business (Chesbrough, 2006). Moreover, in the living lab approach there will be external input throughout the entire process, while in open innovation the focus is on ideas and technology (Smith, 2004).

Open innovation often leads to effective outcomes, but is not without risk. Entirely opening up the innovation process and development activities, means opening up to any interested parties (Westerlund & Leminen, 2011). In order to gain the right insights for the innovation process, collaboration between stakeholders of different backgrounds is necessary, who have different perspectives on the problem and possess different knowledge. Openness has a positive effect on the creativity of a group (Eriksson et al, 2005). It is important to include both larger firms and SMEs. According to Feurstein et al. (2008) participation of all stakeholders can be seen as the most essential element of the success of the living lab approach and for its continuity.

2.2.2.1 Stakeholders in a living lab

What differentiates living labs from already existing open innovation processes or co-creation with the end-user is that this methodology is a pioneer as matchmaker between different stakeholders; the so-called quadruple helix at regional and city level (ENoLL, 2016). The quadruple helix model of Carayannis and Campbell (2009) is an extension of the triple helix model developed by Etzkowitz and Leydesdorff (2000). The cooperation model distinguishes 4 'helices' that intertwine and together embody an innovation network: governments, academia, industry and civil society (Parveen et al. 2015), in which the

civil society is the 'fourth helix' that is added to the triple helix model. It is of importance to involve the public in the advanced innovation framework in order to increase and enhance knowledge production (Carayannis et al., 2011). Quadruple helix innovation system frameworks' objective is to develop innovations that are valuable for users and therefore put the (end)user at the heart of the innovation process (Arkil et al. 2010). These innovations can be product, service, technological, social, noncommercial or commercial innovations (Parveen et al. 2015).
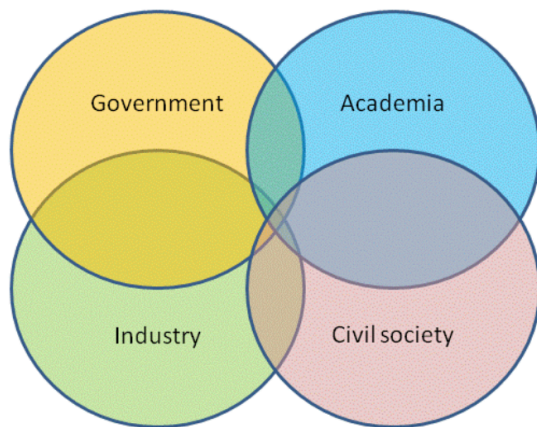

Figure 1: The Quadruple Helix Innovation System Framework – Carayannis et al. 2010

The quadruple helix innovation system framework places a stronger focus on cooperation in innovation and, in particular, the dynamically intertwined processes of co-opetition, co-evolution, and co-specialization within and across regional and sectorial innovation ecosystems (Carayannis, 2008; Carayannis and Campbell, 2009, 2012). Quadruple helix innovation system framework is used in living labs to find solutions for society's problems (Maas et al. 2017). The actors and their contribution will be discussed below. It is important that all living lab stakeholders are involved from the beginning in order to obtain the best possible outcome (Carayannis et al., 2018). According to Kviselius et al. (2008) living labs are 'a new focal point for multi-organizational collaboration on innovation.' Working with so many stakeholders is a daunting task keeping all of them engaged and managing different needs and expectancies (Paskaleva et al. 2015).

Government

The government, or rather public authorities involved as stakeholder derive from multiple levels; state, provincial, regional or local (Carayannis et al. 2018). Most often, local governments or municipalities are involved in the innovation process, since living labs' outcomes are intended to provide local solutions. According to the research of the Rathenau institute on living labs in the Netherlands, local municipalities

are involved in 64% of the living lab initiatives investigated (appendix 2) (Maas et al., 2017). These actors cultivate a long term perspective and have a regulatory role (Steen et al. 2017). Schuurman et al. (2016) calls this group of actors *enablers* who provides resources and create beneficial conditions for the innovation process. These resources are for example financial aids, knowledge contribution or the provision of test rooms. From the governments' point of view, living labs are being used to solve urban/societal problems such as safety, social distance, and mobility. Co-creation with different kinds of parties/stakeholders will promote solving these complex problems and create economic and social value (Maas et al., 2017; Schuurman 2016).

Industry

The industry refers to organizations or private actors with practical know-how and resources (Steen et al. 2017). These organizations can be small or medium sized enterprises or major companies (Caryannis et al., 2009). In the Netherlands, major companies and SMEs are almost equally represented in living lab initiatives and only 1 in 5 projects does not have either of them as a participant (appendix 2) (Maas et al., 2017). Organizations see living labs as a new form of open innovation in which they cannot only cooperate with other organizations and universities but also involve the end-user and civil society in their innovation processes, which can be very valuable (Maas et al., 2017). Schuurman et al. (2016) makes a differentiation between *Utilizers* and *Providers*. Utilizers or 'ad hoc consumers or partners of the living lab' use living labs strategically to develop their business within the innovation ecosystem. These, often commercial, firms collect data on end-users who test their products and services and also collaborate with the other stakeholders. Providers are usually private companies that support actors in the living lab with their products and services. They provide the material infrastructure for operations within the living lab. From the providers' point of view, living labs are used to co-create new products, services and solutions for their industry, with a long-term vision.

Universities

Universities or other knowledge institutes contribute their expertise and scientific substantiation to the living lab (Steen et al. 2017). Living labs are positioned as an interpretation of 'open science' or 'socially responsible research' in which non-academic stakeholders are involved too in the valorisation of research. From the universities' perspective, living labs help knowledge institutes to give practical meaning to their social mission and valorisation task (Maas et al., 2017). Researchers participate in the living lab to exploit implementable knowledge and to explore new knowledge (Schuurman et al. 2016). In the Netherlands 55% of the living lab initiatives have a university as participant and 35% another

knowledge institute. It is remarkable that 45% of the living lab initiatives does not have a university as participant and 25% does not have an academic stakeholder at all (Maas et al., 2017) (appendix 2).

The Civil society

Collaboration with citizens or users is a characteristic that distinguishes living labs from other public-private research and innovation initiatives. Therefore, living labs are often referred to as citizen-public-private partnerships or public-private-people-partnerships (4Ps) (European Commission, 2016). Looking at the literature, apart from defining the concept of living labs, most research has been done on co-creation with users (civil society). The user will be co-creator, co-producer and lead user (Arkil et al. 2010). Co-creation with the end-user enables the stakeholders in the living lab to thoroughly understand the existing and emerging users' needs and to better meet those consumers' wants and needs (Greve et al. 2016). From the user's perspective the added value of participation in a living lab is to have a say in the production and content of the product or service they will eventually use (Kviselius & Anderson, 2009).

2.2.2 Continuity

According to CoreLabs (2007), continuity in a living lab highlights the importance of good cross-border collaboration in order to strengthen the innovation process and creativity.

Good cross-border collaboration in living labs builds on trust (CoreLabs, 2007) which takes time to build up (Bergvall-Kåreborn et al. 2009). Trust plays an important role in organization networks; it means that the actors take each other's interests into account and reduces uncertainty among participants (Klijn & Koppejan, 2012). Trust enhances information sharing and the development of innovative solutions (Lane and Bachman, 1998). Trust can be described as 'the willingness to accept vulnerability based on positive expectations about another's intentions or behaviors' (McEvily et al., 2003). Nevertheless, it is not always necessary for everyone in the network to trust each other in order for the network to succeed as a whole and rather have a centralization of trust relations (Provan & Kenis, 2017). According to Provan and Kenis (2007), the level of trust density must be consistent with the network governance. Relations between actors in a network are called 'ties'. For example, when there is a shared governance, so without network broker, trust ties within the network must be dense. As the level of brokerage in the network increases, trust ties might be less dense while the network can still be effective.

Trust within the network can be strengthened by giving participants the feeling that their opinions and needs contribute to the innovation process (Alcotra, 2013). To enhance trust in an organizational

network, frequency is important. Frequent interactions among stakeholders establish the conditions for structural and relational embeddedness (Jones et al. 1997).

2.2.3 Empowerment of users

This principle underlines the importance of user's needs and desires that need to be taken into account. The innovation needs to be based on these needs and desires and users need to be involved to utilize their creative power (Bergvall-Kåreborn et al., 2009). There are different methodologies to involve the user in the innovation process.
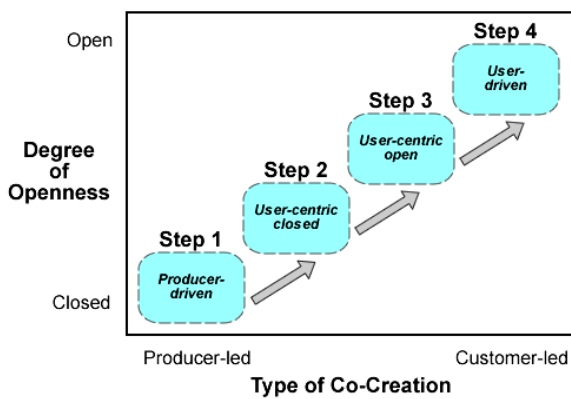

Figure 2: Four steps to becoming an open innovation company – Westerlund & Leminen (2011)

Involving users in the innovation process is not a new idea. Organizations see users as a valuable source of information and collect feedback to adjust their products (Edwards-Schachter et al. 2012). Westerlund and Leminen (2011) discuss the increasing degrees of user-involvement towards becoming an open innovator (fig 2). The first step is characterized by technology push since the innovation process in closed and development is producer-led. Intellectual property and knowledge is kept within the company and there is little interaction with users. These producer-driven companies often use consultancy firms or other intermediaries to collect feedback from users on their products, since they lack the skills and resources to interact with users. In the second step the user is more involved but development is still in the hands of the producers. The users are often involved in either the early or later stages of the innovation process by means of a survey to collect ideas, but organizational culture often fails to support a complete user-centric innovation process. In step 3, the user-centric open approach, customers have more influence in the development process, but are only involved in the process once. The approach is

more towards open innovation, since the user is seen as a valuable source of information. Nevertheless, the user is not involved throughout the entire innovation process. The last approach, used in living labs, is the user-driven approach in which there will be an intensive, long-lasting relationship with the user and user involvement will be at heart of the innovation process.
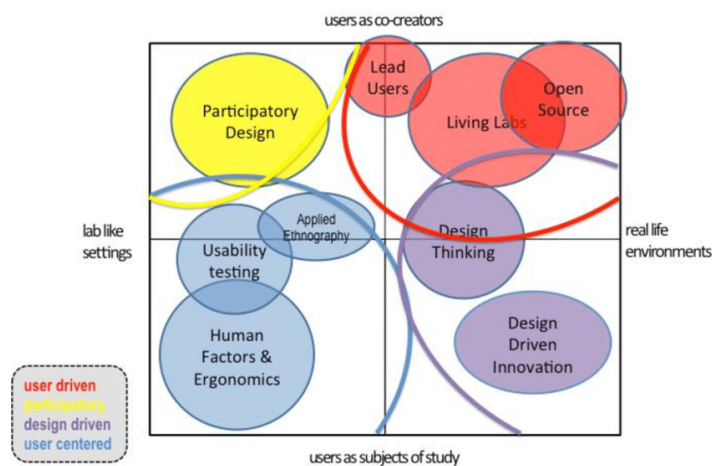

Figure 3: Landscape of innovation methodologies – Almirall et al. 2012

Almirall et al. (2012) and Dell'Era & Landoni (2014) distinguish between four different user involvement methodologies, which are compatible with Westerlund & Leminen (2011). The first methodology is *user centered* (blue) in which users are involved as subject of study and users will not have input in the innovation process. The second methodology is *design driven* (purple) in which designers, who seek to find novel solutions, take the lead in the innovation process. The third methodology is *participatory design* (yellow) in which users are seen as co-creators and equal partners, but research is conducted in a lab like setting. The last methodology is *user driven design* (red) in which the user drives the innovation process. The innovation approach will shift from 'design for users' to 'design with users' (Sanders, 2002). As you can see in figure 3, living labs are an example of user driven design, as stated before by Westerlund and Leminen (2011).

The idea behind user-driven innovation is to get access to the ideas and knowledge of users and not to see them as an object (Von Hippel, 2005). It is important in a living lab to see the end-users as an active partner and take into account that this group usually is heterogeneous. Also, there often is a difference in living labs on how much influence the end-user has. An open mindset toward sharing and collaboration is necessary for co-creation to succeed (Mulder & Stappers, 2009.). Knowledge of domain experts and user needs need to be carefully balanced (Bergvall-Kåreborn et al., 2009).

The living lab approach differs from other approaches due to the fact that users are involved in every stage of the product development lifecycle (Eriksson et al. 2005). Users are often involved in the design, development and validation of products, instead of only the testing phase (Leven & Holmström, 2008). It is of value to involve the user early in the innovation process to discover existing and emerging needs. Innovations in a living lab are created to fit in the lives of the users, making early engagement of the user important. Although, users are supposed to be heavily involved in the living lab innovation process, in practice the user is not always involved in every development phase (Mulder & Stappers, 2009).

2.2.4 Realism

Realism is an important distinguishing principle of the living lab approach. This principle highlights the importance of innovating in an environment that is as realistic as possible. Realism consists of many different elements, such as users, contexts, technologies and use situations (Bergvall-Kåreborn et al., 2009).

Within living labs, users are studied in their real-life context. A real-life context implies that the environment is a resemblance of the user's natural environment as much as possible (Veeckman et al. 2013). The lab will not be in a closed, controlled environment, but become larger and more lifelike also sometimes referred to as 'research in the wild'. This can also entail an entire district or even entire city. Product development in a real-life context is what living labs distinguishes from other user-driven innovation processes (Mulder & Stappers, 2009). Testing in such environments is complicated, with ethical issues regarding safety and privacy, but on the other side benefits the innovation outcome (Maas et al. 2017). As mentioned before, it is important to develop products that fit into the lives of the user. Therefore, the developers must create or find a setting in which they can understand the context of the product use (Mulder & Stappers, 2009). Innovation outcomes or prototypes can be validated in empirical environments within regional contexts (Schumacher & Feurstein, 2007). Hence, innovating in such a real-life setting brings results that are valid for real markets. Products can either be tested in a setting that is similar to that of the end-user, or in the user's real world environment (Bergvall-Kåreborn et al. 2009). An important advantage of the living lab approach compared to other approaches is it's the multi-contextual sphere in which products are developed and validated. It is possible, for example, that the co-creation takes place in one Living lab, while the validation takes place in another (Feurstein et al. 2008).

Realism also refers to the fact that every person has a different interpretation of the problem and different motivations. What might be important for one user, might not be important to another. Hence, it is important to gain different perspectives in the innovation process (Bergvall-Kåreborn et al. 2009).

Not only among users, but also among stakeholders it is important to take into account the different perspectives. What might be important to one living lab partner might not be important to another partner. Therefore, stakeholders should be engaged in the development process as well and should be able to have their say throughout the process (Dutilleul et al. 2010).

2.2.5 Spontaneity

In order to improve the living lab performance, it is important to meet personal desires, inspire usage and contribute to societal needs. For the Spontaneity principle it is important to have the ability to capture spontaneous reactions of the user over time in order to generate new ideas in the innovation process. It is important for the development process that personal desires are met and that the innovation outcome contributes to social needs (Bergvall-Kåreborn et al. 2009). Heterogeneous methods and tools are used within the co-creation process in living labs to interact with the user. Therefore, it's hard to compare the results across living labs (Feurstein et al. 2008).

There is a wide variety of methods and tools that can be used to extract the user's needs and methods and tools differ across different product development stages (appendix 3). Examples are interviews, focus groups, storytelling and participatory design (Schumacher & Feurstein, 2007). By interacting often with users, it is possible to detect changes in their situation and make adjustments to the product or service (Ståhlbröst 2012).

The living lab innovation approach can be divided into four different phases, according to traditional product development phases (Schumacher & Feurstein, 2007):
- The product/service idea generation phase
- The product/service concept generation phase
- The product/service development phase
- Market launch

In order to generate ideas, in the first phase, the method of interviewing is often used in Living labs, which gives room for users' spontaneous reactions. Other frequently methods used are storytelling, empathic design and focus groups (Feurstein et al. 2008).

In the concept generation phase, user involvement is often characterized by user design as methods. Within the product development in living labs the methods of 'test with lead user' is also a widespread method.

Usability tests with users and customer workshops are often used in the product development phase in living labs. Prototypes can be tested in real-life or virtually. Methods used in the market launch phase do not really differ a lot from those in the development phase. Often, usability tests and product tests are used in this phase as well (Feurstein et al. 2008).

However, there does not exist any guidelines which methods should be used in which phase of the innovation process. This is different for every living lab and depends on the goals of the project (Feurstein et al. 2008).

2.3 Performance

In order to determine how the living lab cases are performing, it is of essence to define performance metrics. The living lab literature is silent on the performance of living labs. Therefore, this research will look at the literature of organizational networks. Living lab is an approach but also a network of organizations.

As mentioned before, within the quadruple helix of living labs, multiple organizations work together to achieve a common goal. This quadruple helix can be seen as a network of organizations. Evaluating the effectiveness of an organization network is a complex task and there are many different approaches in the literature (Turrini et al. 2010; Parent & Harvey 2009; Provan & Milward 1995; Oliver 1990). Turrini et al. 2010 evaluates networks in terms of increasing client satisfaction, increasing efficiency, increased legitimacy, resource acquisition and reduced costs. Parent and Harvey 2009, look at the process, impact, outcome, formative and summative of a network, with satisfaction of partners and project outcome as determination of effectiveness. According to Provan and Kenis (2008) network effectiveness can be determined based on the extent to which a network has achieved its pre-determined goals.

Every criterion for evaluating network effectiveness can be used, but the researcher must be clear about the normative character of the measurement (Provan and Kenis, 2009).

To evaluate the performance of the living lab approach on the smart living innovation process the following criteria are being considered:

1. *(Perceived) Effectiveness.* Does the living lab approach contribute to the effectiveness of the innovation process or effectiveness of the innovation outcome?
2. *(Perceived) Efficiency.* Efficiency is about reduced time and costs. Will the principles of the living lab approach reduce time and costs in the innovation process?
3. *Overall satisfaction of stakeholders.* Are stakeholders satisfied with the network collaboration and (possible) outcome?

2.4 Network Governance

According to Westerlund & Leminen (2011), living labs differ from each other based on which stakeholder drives the activities of the living lab. Different stakeholder groups can be the promoter of innovation activities. Living lab networks can differ in the way they are coordinated, the party that coordinates the living lab and participation in those networks (Leminen, 2013).

Leminen (2013) distinguishes between four different kinds of living labs: Utilizer-driven, Enabler-driven, Provider-driven and User-driven.

Utilizer-driven living labs. In Utilizer-living lab, the coordinating party usually is a commercial organization aiming to collect data on the user's product use. The focus of the living lab will be the testing and developing of products and services. The living lab activities will be based on the objectives of the utilizer and the living lab will be used as a strategic tool to collect data on user' feedback. Utilizers will be able to develop or verify new products with the help of other participants in the network. The life span of a utilizer-driven living lab is usually short, due to utilizers striving for rapid results.

Enabler-driven living labs. Enabler-driven living labs are coordinated by a public-sector actor, such as a municipality. The aim of the living lab is to address societal needs, for example reducing local unemployment. The enabler has the largest interest in the living lab and usually involve other parties for

an extended period of time. Organizations not often participate in these living labs, because they do not see the added value.

Provider-driven living labs. Provider-driven living labs are also coordinated by different kinds of organizations. These organizations often do not have a large economic interest like utilizers and are referred to as developer organizations. Examples are educational institutes, consultants or universities. The purpose of the living lab usually is theory development, promoting research and finding solutions to specific problems. The aim is to improve the user's everyday life, while simultaneously let the participants benefit from the innovation. Benefits can be, for example, practical business solutions or new research outputs. Providers might have difficulties attracting utilizers and enablers in their living lab.

User-driven living labs. User-driven living labs are initiated by user communities. Although, they are not coordinated by users. Operations are often facilitated by a provider, but have a bottom-up approach. Other participants in the network will support the user with their knowledge, mentorship, equipment or guidance. The aim is to solve users' everyday problems, mainly for the users in the community. However, these kinds of living labs are quite uncommon and informally organized.

One significant characteristic of living labs is that it is an open innovation network with multiple stakeholders (Westerlund & Leminen, 2011). As mentioned before, not only do living labs have a different coordinating party, they also differentiate in the way they are coordinated (Leminen, 2013).

Inter-organizational networks are characterized by informal social systems rather than bureaucratic structures. This mechanism of inter-firm coordination is referred to as 'Network governance'. Network governance is not a static entity but rather a dynamic process of organizing (Jones & Borgatti, 1997). Cornforth et al. 2015 describe network governance as: "the governance of a collaborative entity entails the design and use of a structure and processes that enable actors to direct, coordinate, and allocate resources for the collaboration as a whole and to account for its activities". Governance in the traditional form is focused on the role of the board of directors who are responsible for protecting and representing the interests of shareholders (Fama & Jensen, 1983). Since networks are not legal entities, governance in network arrangement is often not explicitly addressed. However, some form of governance is necessary to engage participants, to address conflicts and manage interactions, and to ensure that resources are utilized and acquired efficiently and effectively. Thus, governance of activities is necessary for effectiveness of the network (Provan & Kenis, 2007). It is a rather daunting task to achieve satisfactory

outcomes without facilitating interaction processes between actors and coordinate the network (Klijn & Koppenjan, 2012).

The living lab provider should provide efficiency, transparency and smooth integration to engage the living lab participants and establish a climate of co-operation (Feurstein et al. 2008). The participation and collaboration of people in decision-making processes is important, and differs among living labs (Edwards-Schachter et al. 2012). Good governance is important to keep involved partners committed and aware of their responsibilities (Mulder et al. 2008). According to Leven and Holmstrom (2008) the living lab provider should engage in active project management from the beginning. They should make clear what is expected from the stakeholders and make sure it benefits every stakeholder group. To enhance network effectiveness, the coordinators of an organizational network should define a clear strategy and goals to commit network participants. Moreover, the network needs to be managed as a project where there are regular meetings, members need to be motivated, and there needs to be a clear division of tasks (Planko et al. 2017).

3. Conceptual model

3.1. Propositions

Based on the literature review, multiple constructs are defined, with which propositions are set up. With help of the propositions this study aims to find the impact of each living lab principle on the performance of the living lab. Subsequently this research will look at the way in which these principles should be practiced in order to enhance living lab performance by answering the aforementioned research question:

How should the key principles of the living approach be practiced in order to enhance the living lab performance, moderated by network governance?

According to the literature, openness will lead to increased knowledge and more rapid progress (Erikson et al. 2005), which benefits the living lab performance. This will lead to the following proposition:

P1: Openness has a positive effect on the living lab performance.

Continuity is based on trust, which can be enhanced with frequent interaction among stakeholders and building stable relationships. Continuity is important in a living lab in order to strengthen the innovation process and creativity (CoreLabs, 2007). This will lead to the following proposition:

P2: Continuity has a positive effect on the living lab performance

According to the literature, users are a valuable source of information (Edwards-Schachter et al. 2012). Taking into account their needs and desires, will benefit the living lab performance, because innovations will better meet the needs of users (Bergvall-Kåreborn et al., 2009). This will lead to the following proposition:

P3: Empowerment of users has a positive effect on the living lab performance.

According to the literature, practicing realism in a living lab will lead to innovations that are valid for real markets (Schumacher & Feurstein, 2007) and will therefore positively impact the living lab performance. This will lead to the following proposition:

P4: Realism has a positive effect on the on the living lab performance.

Spontaneity is the ability to detect, aggregate and analyse the needs and ideas of users over time in order to generate new ideas in the innovation process, which will positively impact the living lab performance (Bergvall-Kåreborn et al. 2009). This will lead to the following proposition:

P5: Spontaneity has a positive effect on the living lab performance

This research will add the moderating variable 'network governance'. It is assumed that good governance of the network of stakeholders within the living lab is necessary to keep the involved partners committed. Presumably, the way a living lab is governed moderates the relationship between the living lab approach and the living lab performance. This will lead to the following proposition:

P6: Network governance moderates the relationship between the living lab approach and the living lab performance

3.2 The conceptual model

Based on the aforementioned six propositions, a conceptual model is designed. The conceptual model of this research is illustrated in the figure below.
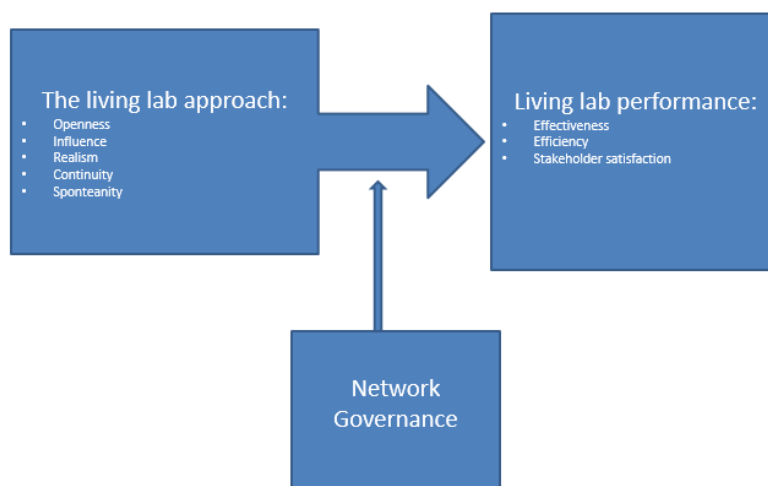

The living lab approach:
- Openness
- Influence
- Realism
- Continuity
- Sponteanity

Living lab performance:
- Effectiveness
- Efficiency
- Stakeholder satisfaction

Network Governance

Figure 4: Conceptual model

4 Methodology

In this section the methodology used in this study will be discussed. First the research approach will be described. Subsequently, the data collection and the way data was analysed will be discussed.

4.1 Research method

The objective of this study is to investigate the relationship between the execution of the living lab approach and the performance of the living lab in the smart living innovation process. For this purpose, a case study approach with three different living lab cases will be executed to identify similarities and differences among cases and the impact on performance. Yin (2009) defines a case study as an "empirical inquiry that investigates contemporary phenomena in depth and within its real-life context, especially when boundaries between phenomenon and context are not clearly evident." Case studies are used to create theoretical constructs from empirical evidence (Eisenhardt, 1989), by exploring similarities and differences between cases (Yin, 2003). The main advantage of a multiple-case study is that multiple situations and sources are used to understand the relationship. This will lead to better insights into the phenomenon and therefore strengthen the findings and validity (Yin, 2003).

By means of interviews, relatively unconstrained data can be conveyed which is very appropriate when exploring uncharted territory (Butterfield, et al. 2004).

In this case study a representative of different helices of the quadruple helix will be interviewed, face-to-face, in order to gain insights from different angles. This will strengthen the validity of the research by finding similarities among personal opinions (Yin, 2003).

4.2 Selecting cases

Since the three cases will be compared with each other it is essential that the cases are chosen with care (Yin 2003). Selecting cases for research is done by means of a database retrieved from the Rathenau institute who made a collection of 93 living lab initiatives in the Netherlands.

When selecting cases from the database the context or objective of the living lab is taken into consideration: smart living innovations. It is remarkable that not a lot of initiatives remain after filtering the database. This may be due to the fact that there are not many living lab initiatives in the Netherlands aimed at smart living innovations. There are a few living labs aimed at elderly care, but not particularly with technological outcomes. From this database the Close-by living lab and the Innovate Dementia living lab were retrieved (see appendix 4).

A telephone interview with a researcher from the Rathenau institute indicated that not all living lab initiatives in the Netherlands were registered in the database and that they primarily looked at living lab initiatives in the University centres. To look for more initiatives to contact, internet research has been conducted. After a few preliminary interviews, the Izi living lab was the only one suitable for this research (appendix 5).

Cases were selected based on:

- The focus of the living lab should be on smart living, technology innovations that enable elderly to stay in their homes longer.
- The living lab should involve a network with all four helices represented (government, academia, civil society and organizations).
- The innovation process within the living lab should be finished or almost finished.

4.3 Data collection

There are multiple ways to collect data in qualitative research. In this research multiple sources are used for data collection to increase internal validity.

4.3.1. First round of interviews

Preliminary to the selection of cases informal interviews were held in order to gain insights in the living lab phenomenon. The interviews were with the living lab coordinators of five different initiatives. After these interviews, three cases remained for research since Medical Delta only in the concept generation phase which would make it hard to compare the cases with each other and Co care-IT did not involve any business stakeholders.

Living lab	Role	Interview Information
Close-by	Living lab coordinator	Face-to-Face, 59 min
Izi Living lab	Living lab coordinator	Face-to-Face, 40 min
Medical Delta	Living lab coordinator	Face-to-Face, 29 min
Co care-IT	Living lab coordinator	Face-to-Face, 41 min
Innovate Dementia	Living lab coordinator	Telephone, 23 min

Table 2: Overview first round of interviews

4.3.2. Second round of interviews

Based upon the first round of interviews and literature review, more in-depth interviews were conducted to gain insights in how the living lab approach is practiced per case. Per case 4 or 5 stakeholders were interviewed to get multi-faceted view on how the living lab approach was practiced in each case. The in-depth interviews are used to explore the participant's perspective on the phenomenon of interest (Patton, 1990). With the semi-structured interviews, a guide (appendix 6) is used with topics and questions up for questioning (Harrell and Bradley, 2009). The respondents will be asked open ended questions which will not limited the interviewees choice of answer (Srivastava and Thomson, 2009). During the interviews the interview guide is used to ask questions with the framework in section 4.4 as a supporting document.

Thirteen interviews are conducted face-to-face and one over the phone. All interviews are between 30 and 60 minutes. Interviews with living lab coordinators lasted between 60 and 90 minutes.

Interviewees selection

The aim when selecting the right interviewees for the case studies is to select living lab partners from different helices of the quadruple helix in order to get a complete view of how the living lab approach is practiced in the living labs. In every case the coordinator or initiator is interviewed first in order to gain insights in the living lab and how it is organized; which stakeholders are involved, what is the goal of the living lab, etc. In order to get insight into the openness and continuity of the living lab, stakeholders from the industry and end-users are questioned. As for the empowerment of users and realism the end-user and/or researchers are questioned. All interviewees were in Dutch. Due to privacy reasons, most interviewees wish to remain anonymous. Therefore, there will hardly be any interviewee referencing in the result section to protect the interests of the interviewees.

Interviewees Case 1: Close-by

Living lab partner	Role	Interview information
Researcher	Living lab coordinator and research on design of platform	Face-to-Face, 96 min
SME	Product development (Technical infrastructure)	Face-tot-Face, 32 min
End-user	Informal caregiver	Face-to-Face, 35 min
End-user	Informal caregiver	Face-to-Face, 74 min
SME	Government intermediary	Face-to-Face, 45 min

Table 3: Overview interviewees Close-by living lab

Interviewees Case 2: Innovate Dementia

Living lab partner	Role	Interview Information
Researcher	Research on design development	Face-to-Face, 50 min
Mental care institute representative	Research and spokesperson for end-user group	Face-to-Face, 54 min
Brainport Eindhoven	Innovation facilitation and international coordination	Face-to-Face, 41 min
SME	Product development	Telephone, 44 min

Table 4: Overview of interviewees Innovate Dementia living lab

Interviewees Case 3: Izi gezond langer thuis

Living lab partner	Role	Interview information
Municipality of The Hague	Living lab coordinator	Face-to-Face, 40 min & 41 min
Municipality of The Hague	Technology coordinator	Face-to-Face, 52 min
End-users	Elderly group	Face-to-Face, group interview, 45 min
Researcher	Research on quality of life and cost efficiency	Face-to-Face, 46 min
SME	Product development	Face-to-Face, 60 min

Table 5: Overview interviewees Izi living lab

4.3.3. Observation

Using observation in qualitative research enables the researcher to observer events that participants are unwilling to share, determine who interacts with whom and check information that participants share in interviews (Marshall and Rossman, 1995). Validity will be stronger with the use of secondary data such as observation (DeWalt, 2002). Observation was done at a stakeholder workshop at KPMG from the Close-by living lab in which 21 stakeholders discussed the market launch phase of their innovation. In addition, observation was done at the flat of the Izi living lab where technology will be matched with the end-user.

4.3.4. Documents

A variety of documents is used to understand how the living lab approach was practiced per living lab. First of all, two final reports were used; one of Izi gezond langer thuis and one of Innovate Dementia. According to Yin (2003), a risk of internal documents is that they may be self-biased. This risk can be minimized during interviews by going in-depth on the different principles. The living lab Close-by is still in the market launch phase and did not have a final report available. However, the living lab coordinator provided me with her dissertation "Developing a Service Platform for Health and Wellbeing in a Living Lab

setting", which will provide insights in the different phases of the living lab innovation process. Also the researcher from the Innovate Dementia living lab provided me with his dissertation "Design for dementia: a design-driven living lab approach to involve people with dementia and their context."

4.4 The Framework

With the help of academic literature from the theoretical framework and some additional first order codes from interviewees' transcripts, a framework has been established to research the living lab approach among the selected cases. When looking at the literature, the five key principles are all multifaceted and tend to overlap with each other. For example, the principle openness contains openness towards the end-user by listening to them and take ideas into consideration. This overlaps with the empowerment of users in which the innovation is based on the needs of the user. Therefore, this framework in this study will incorporate only certain aspects of the key principles, that are not duplicated by another principle. Each aspect will be scored on a Likert scale from 1-5 based on Brown (2010).

Openness

For the key principle openness this study will focus on the composition of the living lab partner network. Which stakeholders are involved in the living lab and what expertise and knowledge exist in the living lab

Amount of stakeholders *
Diversity of stakeholders **
Knowledge present in living lab ***

*1= very few, 2= few, 3= a moderate amount, 4 = many, 5= a lot

** 1 = no diversity, 2 = low diversity, 3 = some diversity, 4 = high diversity, 5 = very high diversity

*** 1= no knowledge, 2= little knowledge, 3= some knowledge, 4= sufficient knowledge, 5= a lot of knowledge

Realism

For the key principle realism this study will focus on the context in which products are tested and the user involved in this process. Also, which participants are involved to provide information? Is it just the user, or other stakeholders as well?

Context *
Different views taken into account **

Users representative for target population ***

Empowerment of user

The key principle empowerment of users in this study looks into the way in which the user is involved in the innovation process and the influence they have on the development of the innovation.

Innovation based on needs of the user *
User involved throughout the entire process **
Weight of the user's voice ***

Continuity

For the key principle continuity this study will focus on the cross-border collaboration between stakeholders. How do stakeholders interact with each other? The focus will be on all the partners as a whole, not with the end-user.

Trust *
Network stability **
Interaction between stakeholders ***

Spontaneity

For the key principle spontaneity this study will focus on the data collection methods that are used during the innovation process. Since these methods are often very heterogeneous among living labs and specific for the goals of the living lab, it might be hard to make a good cross-case comparison. Therefore, a comparison is made in methods used to gain insides into the user's real-life context and needs.

Methods used to gain insides into user's real-life

context and needs

Governance

For the moderator governance, this study will focus on the stakeholder that governs the network of stakeholders in a living lab and the way it is coordinated.

Governance actor
Roles & Responsibilities *
Managing expectations**
Goal consensus ***
Decision-making processes****

*1=no division of roles, 2= low division of roles, 3=semi- division of roles, 4=clear division of roles, 5=very clear division of roles

**1=no management of expectations, 2= low management, 3= semi- management, 4= good management, 5=very good management

*** 1=no goal consensus, 2= low goal consensus, 3= semi-goal consensus, 4= high goal consensus, 5= very high goal consensus

**** 1=no involvement, 2=low involvement, 3= medium involvement, 4=high involvement, 5= very high involvement

4.5 Data analysis

All interviews were recorded with permission, where after each interview was transcribed. Subsequently, the transcribed interviews were imported into the coding software ATLAS.ti.

4.4.1. Coding

This research will make use of deductive coding. Deductive coding means that one will code according to constructs identified in the literature (Sgier, 2012). Transcripts will first be coded in ATLAS.ti with first order codes (appendix 7). The first order codes will be corresponding with the aspects of the framework in section 4.4. Examples of codes are 'user involvement' or 'research context'. To code the impact on the living lab performance, codes like 'realism – efficiency' and 'openness – effectiveness' were used. Although some aspects were designed according to the theoretical framework, it is important to maintain an open mind and don't force data into an aspect (Srivastava and Thomson, 2009). This means some codes can be added to the framework while coding the transcripts. According to Ritchie and Spencer (1994) a framework is only tentative and may be refined during different stages of analysis. Subsequently, the first order codes will be assigned to overarching codes, or second order codes to get a clear overview (appendix8). These codes will correspond to the key principles of the living lab approach; openness, continuity, empowerment of user, realism and spontaneity and to network governance.

4.4.2. Framework analysis

After the transcripts have been coded, first an internal case analysis will be made. In this analysis the codes of the 4-5 respondent will be compared to see any similarities and differences in answers. Different respondents might have a different view on how the living lab approach is being practiced. Subsequently, the framework per case will be filled in (appendix 11;15;18) to determine how the living lab approach has been practiced in each case, based on a 1-5 Likert scale. After the living lab approach per case has been determined as cross-case comparison will be made and the impact on the performance of the living lab.

4.6 Validity

Yin (2003) distinguishes between three types of validity: construct, internal and external validity. All three validity types are taken into account. To ensure construct validity a use of triangulation in research is necessary, to gain in-depth insights into the problem (Golafshani, 2003). Information from different data sources and theories were used in this research. Through a literature review most relevant aspects were identified. Subsequently, documents were analysed, observations were made and semi-structured interviews were conducted with 4-5 respondents per case. The respondents were carefully selected and it was made sure that they were from different stakeholder groups. This ensures a multitude of different perspectives and the construct validity will be ensured.

Internal validity implies whether the reasoning within the study is free from bias. Questions asked during the interviewees were open ended to prevent the interviewee from being biased. All interviews were recorded, transcribed and coded and compared with each other and with secondary data to ensure internal validity.

External validity implies the extent to which the results of the research can be generalized. This validity type will be slightly restricted, due to the scope and limitations of this study. The cases represented in this research may be generalizable for other living labs aimed at smart living innovations since three different cases have been researched, but may not be representative for other living labs. Living labs can be used for all kinds of societal problems, like education or infrastructure.

5 Results

In this chapter the information derived from observations and interviews will be discussed. The first part of the chapter will elaborate on how each key principle of the living lab approach and governance is practiced in each case. Subsequently, a cross-case analysis will be made on the key principles and their effect on performance metrics.

5.1 The living lab approach

Case 1: Close-by (Zo-dichtbij)

Background

The Close-by living lab started in 2013 and is currently in the last phase of the innovation process: the market launch phase. Close-by is an online healthcare platform for elderly that enables them to live at home longer (appendix 9). The platform helps elderly and their informal caregivers to get the right information with regard to care. They will be able to ask questions to healthcare institutions, WMO-counter staff, suppliers and caregivers. Furthermore, the platform acts as an intermediary with on one side the elderly and the other side the suppliers for materials such as stair lifts or walkers. The platform, offered by municipalities, will provide the elderly with information on how to make their homes safe, comfortable, sustainable and future-proof. In conclusion, the platform offers multiple conveniences to let elderly live more comfortable, find the right care materials and support informal caregivers. The platform will be used by elderly and their informal caregivers to improve their quality of life, but also by organizations to offer their products and services, and it could be used for many more user groups in the future, like for example family doctors. The living lab is supported by funding partners, but also through corporate social responsibility contributions of all stakeholders involved.

Openness

The Close-by living lab consists of a large amount of living lab partners. All 21 partners in the living lab are permanent partners that jointly address a complex societal issue. The partners have various backgrounds and all joined the living lab based on corporate social responsibility. A researcher from the TU Delft conducted research on the design of the platform and is at the same time the living lab coordinator. Moreover, three municipalities are involved, two multinationals, seven organizations mostly involved for platform building, several care institutions for reaching the end-user, healthcare innovation partners and a strategic partner. It can be stated that the diversity in the living lab is quite high and since there are also many different partners involved there is a lot of knowledge present in the living lab. As a result, the living

lab does not have to seek for knowledge or resources outside of the living lab. Most partners are involved from the beginning of the innovation process; from idea generation phase till the market launch.

Every two months the entire consortium of 21 stakeholders is invited to come together and discuss the progression of the innovation process. Workshops are organized to discuss several topics such as business modelling or the revenue model of the platform (see appendix 12). Other than that, most interaction between stakeholders occurs in small groups arranged by the living lab coordinator. For example, if the architecture of the platform needs to be discussed, mainly the technical parties will be invited. Furthermore, a lot of interaction occurs bilaterally with the coordinator or via Basecamp an online communication tool in the living lab. The living lab coordinator illustrates:

"Basecamp is our online communication tool on which everyone will post their steps made in the process. It is to keep everyone up to date and partners will have the opportunity to leave a comment."

Only one stakeholder has left the living lab due to conflicting interests.

"Because we already decided to work with the Watson technology of IBM, Oracle made the decision to leave the living lab."

Most of the other partners of the living lab have been a part of the living lab for almost 5 years, which makes the network very stable and shows that the partners are very committed. As a result, until now, trust is very high within the living lab. The living lab coordinator thinks that this might change in the market launch phase when the partners probably all want to grab their piece of the pie. The multinationals in the living lab are less trusted by the other partners. An interviewee declares:

"I think trust is really high in the living lab, but it is not really clear for me why the multinationals participate in this living lab. All partners are quite clear about their intentions to participate, but the multinationals did not declare why they find this living lab so interesting. Maybe they are interested in data or IP rights."

As mentioned before, trust within the living lab is high. That is a good thing, since there are no agreements on performance or contracts:

"This innovation process is not core business for all partners in the living lab, but based on social innovation. Moreover, there are no contractual agreements between the parties nor performance agreements. Nevertheless, commitment is high and everyone performs the task that he is good at and is assigned to."

Empowerment of user

The user is involved throughout the entire innovation process; from idea generation phase till market launch phase. Throughout the entire development phase, the user's voice was most important and every detail is discussed:

> "We were involved throughout the entire design process. We even had a say in the smallest details, such as the colour or logos on the platform. I really had the feeling that my contribution was valuable and my input was used."

There are even two end-users present at the consortium meetings of the living lab, which means they were involved in decision making processes as well. Since the innovation will be used by not only by the elderly (consumer), but also for i.e. by organizations to offer their product the innovation is not based on the needs of the user only, but also on the needs of other stakeholders. They've gathered a multitude of perspectives from the living lab partners and potential end-users, which they will use to design their innovation.

Spontaneity

In order gain insights into the needs of the end-user, a mix of data collection methods is used (i.e. surveys, interviews and focus groups). First a survey and in-depth interviews were held with different stakeholders (organizations and elderly) to define their needs for the healthcare platform. After that, focus groups under the guidance of a moderator were held to discuss problems and solutions to predefined problems.

Four focus groups were set up. The first one based on gender, education level, and background and consisted of the stakeholder groups: end-user, government or organizations. The second focus group consisted of healthcare professionals from the Netherlands and the UK. The third group consisted of potential end-users of the platform: the informal caregivers between the age of 55-75 and the informal caretakers. Candidates of the last group were project partners from a European Ambient Assistant Living (AAL) project from different countries who are working as intermediaries in the healthcare sector.

Realism

In the beginning stage, the healthcare platform was tested multiple times in a test setting at the TU Delft in small groups. The small groups again were with a diversity of users such as informal caregivers, informal caretakers and professional caretakers. During the usability tests the candidates were asked to

complete several tasks after which design alterations could be made. The usability tests were done with a different group of users every time, which came from different places or healthcare institutions and with a difference in age. One of the users illustrates:

"There were people with knowledge of technology, like me, but also people who were extremely premature. We had informal caregivers, but also older people. In my opinion the group was representative for the possible target group."

The living lab tested their product in multiple contextual spheres; at the TU Delft, but also in the home environment of the user. The platform was tested in the user's home for a longer period of time or observation took place while the user was using the platform. In addition, the follow-up prototypes were developed and tested with different stakeholder groups: suppliers, care professionals and WMO-counter staff who all provided feedback. Also the demo was sent to 150 random people who could give feedback on any functionality. The living lab coordinator illustrates:

"We innovate in a real-life context and our research is 'in the wild', which means that wherever the problem exists, that is where we will go. If it is about how suppliers should offer their product on the platform we will go to the suppliers. Also, we don't apply one method for testing our product but we involve different kinds of people in different contexts."

Network Governance

The living lab is coordinated by one person who wrote her dissertation on the design of the innovation outcome of the living lab. She is a researcher at the TU Delft and works for the foundation Close-by (also the name of the innovation). With the living lab she aims to find a solution that will support elderly (user) in their daily life. Therefore, the living lab can be seen as *a provider-driven* living lab.

Based on a short questionnaire and additional interviews, the living lab coordinator identified the roles and functions and the expected benefits for all partners involved in the Living lab and wrote them down. The living lab coordinator declares that it is important to manage expectations of stakeholders:

"It is important that the living lab partners keep their own goals and interests sharp and be open about it. In my opinion managing expectations is very important. Be transparent about the process and don't promise things that you can't deliver."

The living lab coordinator established a clear roadmap with goals that need to be achieved.

"I have made a roadmap with deadlines mainly for myself and based on that roadmap I instruct the other living lab partners."

As mentioned before, the living lab coordinator organized workshops in which the stakeholders can democratically decide on certain elements of the platform. Some subjects or elements of the platform will be discussed in a smaller group, for example, the technical group or the user group. The final decision will be made by the living lab coordinator, but with input from all stakeholders.

She declares:

"*I make the final decision, but I listen to the other stakeholders. If the municipalities for example say, "this does not sound like a good plan", then I will listen to that. They have the expertise in that area and I don't. In the end, I have less knowledge compared to the other stakeholders in the living lab when it comes to certain things.*"

Although the stakeholders have different expected benefits from the living lab, they all have the same goal to aim for: build a platform that enables elderly to live in their homes for as long as possible.

Case 2: Innovate Dementia

Background

Innovate dementia was a living lab project that started in 2012 and ended in 2015, with the goal of addressing the societal challenge of dementia. The project funded by the European Union was spread over four regions: Antwerp-Geel, Belgium; Krefeld, Germany; Liverpool, UK and Eindhoven, the Netherlands. The latter will be the focus of this case study. Each region had its own network of stakeholders and partners to address the challenge. The goal of the project in the Netherlands was to analyse the needs of people living with dementia, the development of innovative solutions and to strengthen the economic activity in the region of Eindhoven. They were trying by means of a design-driven approach to find new strategies and design proposals to support people living with dementia. People living with dementia have a cognitive impairment, which makes the innovation process challenging. Within the living lab some products are developed from scratch, such as the homing compass and the reminder system PHYSICAL (see appendix 13). Additionally, business stakeholders use the living lab to test their products and refine their innovations. Examples are the GoLivePhone – a software interface for smartphones specifically designed for older people and Vitaallicht – a dynamic lighting system that positively influences the sleeping/waking cycle of people with dementia (appendix 13).

Openness

The Innovate dementia living lab consisted of a dense network with very few stakeholders: the mental care institute GGzE that focused on the needs of people living with dementia, the TU Eindhoven that focused on the design of concepts, Brainport who was in charge of international coordination and the business stakeholder network and finally the municipality of Eindhoven which connected social organizations. The core group of stakeholders of the living lab build a network of business stakeholder to cooperate with. The network of business stakeholders was not part of the core living lab partners and was only involved in the last phase of the living lab. This means that diversity was not really high and there was not sufficient knowledge in the living lab, which means they had to seek for external parties throughout the process to complement the knowledge in the living lab. "*We were attracting business stakeholders to expand our knowledge and improve our processes, while the organizations were able to develop their products.*"

Continuity

The consortium of the living lab had a meeting every six weeks to discuss the progression of the living lab project; with the GGzE, Brainport, TU Eindhoven and municipality of Eindhoven. The GGzE and TU Eindhoven had weekly meetings and carried out most of the tasks within the project. The municipality and Brainport were not that much involved in the living lab. The TU Eindhoven worked on the design of the innovations and the GGzE provided people living with dementia for co-creation. Interaction with the business stakeholders occurred more bilateral and they were not really involved. According to a business stakeholder there was too little interaction with the living lab consortium:

"*Communication was not that good, we had to approach the living lab ourselves.*"

The consortium formed a stable network in which trust is very high and the partners are very satisfied with the collaboration:

"*There was a lot of respect for each other. Everyone had its own role in the project, but we were also a team. That is important. I had the final responsibility, but I could leave everything to the other partners. They were really professional.*"

On the contrary, the relationships with business stakeholders were almost all short term and the consortium didn't trust the business stakeholders that much. An interviewee from an organization declares:

"I had a feeling that they distrusted organizations, because they were afraid we would grab their money. In healthcare budgets are often so tight and they are afraid that organizations will take that away from them."

There were no contractual agreements within the living lab. Within the consortium that was not necessary since trust is very high, but one of the interviewees says:

"We didn't really have contractual agreements with our business stakeholders, more a kind of project plan, looking back on that it would have been more convenient to have contractual agreements with that stakeholder group."

Spontaneity

The living lab used a various set of ethnographical research methods to gain insights into the lives of people living with dementia. The living lab needed to choose their approaches so that they are suitable for people with dementia. These are an adapted diary study, a focus group study and an interview-based study. In the adapted diary study for people with dementia, candidates were asked to keep a diary in which he or she records his or her thoughts and feelings under the direction of a researcher. This enabled researchers to capture rich data on feelings, beliefs and personal motives. The diary study is modified by including photo and audio diaries to understand the participants, including their environment better.

During interviews the strategy labelled 'reflection-by-doing' was employed. In this strategy retrospection was avoided, which is particularly difficult for people living with dementia.

The data gathered from the diary study and interviews is analysed and used to determine the topics for the focus groups.

Realism

Not only elderly, but also their informal caregivers were involved in the research, especially in focus groups. They might be useful as spokespersons, while at the same time the researcher is able to gain better insights into the lives of the candidates. Professional caregivers needed to be involved to continuously assess the status of consent and are also involved in focus groups together with user representatives.

"We involve professional caregivers and user representatives to gain better insights into the lives of people living with dementia, but also to improve the legitimacy of our living lab in the mental health sector."

The researcher declares that it was important to segment the research activity into smaller parts to reduce the burden of participation for elderly.

The prototypes were tested in a context that is as realistic as possible: the home environment of the people living with dementia. The people involved in the research were people with early mild-stage dementia, because they still have a sense of self. This only represents a sub-group of the target population. The living lab had a cohort of 100 people in which they used a different amount of candidates per innovation process:

"It was hard for us to attract a lot of people to participate. One of the first symptoms of having dementia is to have a lack of initiative, that could be a reason why it was so hard."

These candidates came from the GGzE, but also from other care institutions.

Empowerment of user

Some innovations were based on the need of the user, like the homing compass and the PHYSICAL calendar. In these cases, the user was involved throughout the entire process, except for the market launch phase. On the other hand, the living lab cooperates with business stakeholders who were able to test their products with users. In this case, the user is only involved in the product development stage. Users were able to provide feedback, but are not involved in decision making processes. The GGzE was part of the consortium and was involved in meetings on behalf of the user, but the user was not directly involved. The weight of the user's voice in new product development was high, since it was totally based on their needs. When it comes to the already existing products, user' input was limited since the products were developed by organizations beforehand.

Network Governance

The Innovate Dementia living lab was mainly coordinated by the researcher and partner from the GGzE who are in close contact with each other. Among the consortium partners an agreement had been made that every six weeks another living lab partner fulfils the role of chairman during the consortium meetings. The living lab was aimed at user' needs, and can therefore be described as a provider-driven living lab, in which governance is shared.

The living lab had some problems regarding the organization of their living lab. Also due to the fact that five years ago the concept of living labs was very new and there were almost no cases to learn from. According to one of the interviewees there was no overarching project management:

"The living lab should have brought some disciplines together: communication, budgets, writing down your goals. That is basic project management. They should have thought in advance about how to work together and how to involve the industry. Take that party serious as a stakeholder in the project and involve them in the planning process."

One of the coordinators agrees on the fact that they'd some trouble with project management:

"The biggest challenge in the living lab was to make a clear division of roles and responsibilities. It took us a while before we knew okay this is going to be our focus and this is how we are going to get there."

In the living lab, there is a discrepancy between the goals of the consortium and the goals of the business stakeholders. There is no goal consensus and the expectations of business stakeholders are not well managed. One of the interviewees of Innovate Dementia declares:

"The focus of the living lab coordinators was to study how to ask the right questions to people living with dementia, while I wanted to know if my product was working, but that didn't get an answer to that. If the coordinators would have involved business stakeholders, they would be able to talk about their interests and goals in the innovation process beforehand, which will make the managing of expectations more easy for the coordinators. If they would have been more open about their research goals, I would have said in advance that this was not going to work. I felt like they were pushing their research interests and were not really concerned about our interests."

Decision-making processes within the consortium were very democratic and commitment was high. Organizations were not involved in decision-making processes, because they had different interests. One of the coordinator declares:

"We noticed that the business stakeholders were very impatient. They don't understand that it takes a lot of time, especially when you work with people with dementia. Therefore, we did not include them in our meetings. Because it's about the interest of the user."

Background

The Izi gezond langer thuis living lab is an initiative of the municipality of The Hague that started in 2015. The project is aimed at the elderly inhabitants of the city to let them live in their homes for as long as possible with the help of ICT-enabled technologies. The project acts as an intermediary between the supply of technology and the demand of elderly. They've furnished an apartment within a neighbourhood of the city, equipped with all sorts of different technologies; from low-tech to high-tech. Elderly in the neighbourhood are able to experience the technology and so it increases awareness of what's out there. Subsequently, they are able to take some innovations home to test them for a longer period of time. Research indicates whether it will improve their quality of life. The aim is to let elderly live in their home environment for as long as possible, let the elderly become acquainted with technology and to strengthen interconnectedness between neighbours. Within the living lab, existing technology is matched with the need of the user, but also technologies such as a care robot are refined and developed. Examples are a smart rollator and a sensor system to monitor lifestyle of elderly. The goal of the municipality is to stimulate healthcare innovations and to build an infrastructure, where innovations can be offered and multiple parties are responsible for the healthcare costs instead of the municipality alone. The municipality coordinates the living lab, but also finances everything.

Openness

The Izi living lab, led by the municipality of the Hague, consists of 6 partners: the municipality of The Hague, LUMC, University of Tilburg, Haagse Hogeschool, Haagwonen and Xtra. The living lab is initiated by the municipality of the Hague who started with Izi as a project and later on invited other partners. The University of Tilburg is doing research on the matching of technology with the needs of the user, while the LUMC is doing research on whether technology will improve the quality of life of citizens and the cost effectiveness of the use of technology. Students of the Hogeschool are doing research on design features of some innovations, Haagwonen provides the flat equipped with technology and Xtra provides the consultants that communicate with the user. In addition, some resident associations are sometimes involved such as Parnassia. The industry is not directly involved, but the living lab has cooperation agreements with this stakeholder group and involves them only in the product development of market launch stage of their innovation process.

Continuity

There used to be a helix meeting with the 8 aforementioned living lab partners, but there is not a meeting anymore which means that the partners in the living lab do not interact with each other. Most interaction occurs bilateral with the municipality of The Hague or it could be arranged if 2 parties want to interact with each other. One of the interviewees says:

"I do not really collaborate within the living lab. I've got a task assigned, and I will perform that task. At one point I suggested that perhaps I could add more knowledge to this living lab given my profession as a doctor, but they wouldn't listen to that."

Another interviewee declares:

"What this living lab actually is, is a group of freelancers who separately perform their task and making money, instead of looking at the bigger picture."

The researcher is in contact with the user to collect data for research, organizations are also in contact with the users to test and develop their products and the municipality facilitates it all. Since there is not really collaboration within the living lab and every stakeholder performs its own task, the living lab makes use of contractual agreements with all partners. This often means that trust is low, or there is no trust within the living lab. Contractual agreements with business stakeholders are for a period of one year; the municipality pays the industry to demonstrate their product. Network stability with business partners is therefore low and again there is no real co-creation with different stakeholders. The group of 8 stakeholders used to discuss the progress and strategy of the living lab, but that stopped. Therefore, the network cannot be described as a very stable network.

Spontaneity

The municipality, in cooperation with a team of professionals, conducted the "Leefwereld onderzoek" in which 80-100 inhabitants of the city were interviewed on their future perspective of living at home longer. The team consisted of a community-builder, an innovator, district nurse, ergo therapist and marketing researcher. Following from the interviews so called 'Ateliers' were set up, which could be compared to focus groups. Within these ateliers, 40 participants elaborated on the information obtained from the interviews. Only elderly participated in interviews and the ateliers. Some technologies were showcased in the ateliers, where after the users could give their feedback.

Realism

Subsequently, the project leader technology will search for the technology that matches the needs of the user best, which will be positioned in the flat. One of the coordinators declares:

"*We use the flat to strengthen the community. People will come into contact with each other and motivate each other to use certain technologies.*"

The users are shown around in the flat to see what's out there, after which consultants will engage in conversation with the elderly to make a match between the needs of the user and the already existing technology. After a selection has been made, the technology is rolled out in the homes of the elderly. They are able to test the products for a period of 1 year, together with their informal caregiver. The consultants will ask for feedback every 3 months to see if the user is satisfied and if the supplier should be involved to alter or fix the product. The LUMC will conduct an overall research on if the technology used will improve their quality of live and cost efficiency.

People involved in the research are people who voluntary offered to participate in this living lab process. The consequence is that, mostly vital and active elderly people participate in the research:

"*Out of the 260 people living in the flat, 160 did not participate. These are mostly the more vulnerable elderly or with a different cultural background. This is a target group for which the technologies would best meet their needs.*"

One of the users in the living lab illustrates:

"*I'm testing a sensor monitoring system that checks my hart and long functionality, but luckily I do not need it yet.*"

This indicates that users are not in need of the products, are testing them and providing feedback.

Empowerment of user

Innovations in the Izi living lab are matched with the needs of the user, but are not based on the needs of the user in the living lab. Since the technologies already exist, most organisations developed products that they think meet the needs of the user.

Therefore, the user is not involved throughout the entire innovation process, but in the product development or market launch phase. Technology in the living lab already exists and is brought in the flat for marketing purposes or development of the product. One of the business stakeholders declares:

"*We use the Izi living lab for the optimization of our product and to see our product in different settings.*"

As for the living lab, the users and their opinions are taken really seriously. One of the users declares:

"I really have the feeling that they listen very well to our needs. If we decide an innovation does not match our needs it will be removed from the flat. Moreover, we are in contact with the suppliers to notify them if their product isn't working and to provide feedback on the usability."

Nevertheless, the overall weight of their voice is not that very high when it comes to the innovation process since products already exist. Some design alterations are possible, but there is no real co-creation with the end-user. Moreover, a lot of products are tested in the multiple living labs or test facilities, which means that the users in the Izi living lab do not have a decisive voice when it comes to design. One of the organizations illustrates:

"If we receive feedback on some sort of emergency problem, like a broken fuse we will immediately solve it. But when it comes to design, we will only take things into consideration if we receive it from multiple users from multiple facilities."

Network Governance

The izi living lab started as a project which later on became a living lab. The municipality of The Hague is the coordinator of the living lab and the living lab practices are based on their objectives. The living lab can be described as an enabler-driven living lab. However, they are more facilitating than ruling or coordinating. Partners of the living lab declare that there is no overarching project management or shared goals within the living lab. One of the interviewees declares:

"What we miss in the living lab is an overarching plan and overarching project management and a shared vision in which people collaborate to attain a common goal."

In addition, there is uncertainty about the roles and responsibilities in the living lab.

"There is uncertainty about the division of roles in the process. Who is responsible for what. The group dynamic is really like 'we're all in this together', but in the end no one has a real responsibility, so that didn't get us any further."

As mentioned before, there used to be a helix meeting, but not anymore. Therefore, on higher level there are no collective decision-making processes at all. On a lower level, decision-making processes on the technology happens in a very democratic way with users and consultants.

Most stakeholders within the living lab had different expectations. Organizations expected the municipality and knowledge institutions to be more involved in the user inquiry process and the researcher expected the living lab to be more about co-creation instead of independently performing a task.

5.2 Cross-case analysis

In this section the three cases will be compared based on how they practice the different principles of the living lab approach and what impact it will have on the performance of the living lab. While conducting the interviews it became clear that the Close-by case and the Innovate Dementia case see the concept 'living lab' as an innovation approach, while most of the stakeholders of the Izi case see their living lab as an innovation entity or arena. Moreover, the Close-by living lab aims to find a nationwide solution for the ageing population, while Innovate Dementia is more focused on a region and the Izi living lab focus is locally. Even though the living labs more or less have the same long-term or overarching goal: enabling elderly or people living with disabilities to live in their homes for as long as possible, their goals are very different. The Izi living lab is focused on technology matching and technology acceptance with research on quality of life, while Close-by and the Innovate dementia living lab are really more focused on product design and development. The Close-by living lab is used for new product development, while Izi is used for the validation of products and Innovate Dementia is used for both.

5.2.1 Openness

	Amount of stakeholders	Diversity of stakeholders	Knowledge present in living lab
Close-by	5	5	5
Innovate Dementia	2	3	3.5
Izi	3	3.5	3

Table 6: Cross-case analysis openness. Retrieved from appendix 11, 15 and 18

All three cases apply openness in a different way. The Close-by living lab is a very open living lab in which there is a permanent collaboration between a large amount of stakeholders. There is a lot of knowledge present in the living lab, given the high diversity of stakeholders and looking for complementary knowledge outside the living lab is not necessary. The Izi and Innovate Dementia living lab operate with less openness. Both living labs do not involve business stakeholders in their consortium and have to look for complementary knowledge outside their living lab. Business partners within the Izi- and Innovate Dementia living lab are more *Utilizers* who want to collect data on the end-user testing their products, whereas business partners in the Close-by living lab can be considered *Providers* who use the living lab to co-create new products. An interviewee from the Innovate Dementia living lab declares:

"I think that if we would have involved organizations, who would also be a part of the consortium, that that would have been an added value to the project."

The network of the Close-by and Innovate Dementia living lab consists of more stakeholder groups than just the quadruple helix. In both the Close-by as the Innovate Dementia case, service providers are participating. These service providers deliver services for health & wellbeing, such as the GGzE in the Innovate Dementia case. The Izi living lab does not really involve service providers, which according to one of the interviewees is not really effective, because involving that stakeholder group would add knowledge and resources to the living lab, which impacts the effectiveness of the living lab:

"They say it is good for the project to cooperate with healthcare institutions, the municipality, family doctors and district nurses. This is not happening at the moment. I have been saying that it would be a good move to involve a network of family doctors in the living lab, but they are not open to this idea. My advice is to involve family doctors, because of their knowledge on the subject, but also because they have a database with validated data from which we can pick the right user-group to do the tests with, the once that are more vulnerable. That would lead to more effective outcomes."

The Close-by living lab also adds other stakeholder groups such as multinationals, insurance companies, funding partners and other knowledge institutes other than academia. Apart from the great diversity and knowledge within the living lab, the Clos-by case also has by far the greatest amount of stakeholders in their living lab. The living lab works with 21 permanent stakeholders, while Izi only has 8 and Innovate Dementia only has 4 permanent stakeholders. For this reason, the latter two have to search for knowledge outside their living lab and make agreements with temporary stakeholders such as the industry, which is not really efficient. On the other hand, this large amount of stakeholders can cause a delay in the innovation process. The living lab coordinator illustrates:

"We are dependent on a large amount of stakeholders, which makes coordination hard and impacts the efficiency because you can't act rapidly. In addition, especially with the multinationals, it often happens that the right person in the organization does not sit at the table. Both these facts delay the decision-making processes."

The Izi living lab agrees on the fact that the person from the organisation present in the living lab, may impact the efficiency:

"We are searching for a new structure in which managers from the organisations, present in the living lab, are involved. In this way there is more mandate, and decision-making processes will go faster."

On the other hand, involving multiple stakeholders could also positively impact the efficiency of the innovation process. The coordinator of the Close-by living lab illustrates:

"However, the involvement of multiple stakeholders to explore the design of a business model and platform services, especially at the start of our project, could accelerate the exploration of the platform's potential."

5.2.2 Continuity

	Interaction between stakeholders	Network stability	Trust
Close-by	4	5	4
Innovate Dementia	3	3	3
Izi	2	2	2

Table 7: Cross-case analysis continuity. Retrieved from appendix 11, 15 and 18

Continuity is about the interaction and stability of the partnerships within the living labs. When comparing the cases, you can see that when it comes to continuity, in the Innovate dementia and the Izi living lab continuity is lower compared to the Close-by living lab.

Within the Close-by living lab stakeholders interact frequently with each other and the innovation process is very transparent with the help of ICT tools. Attending one of the workshops of Close-by with around 20 stakeholders around the table, showed how committed all the stakeholders were, because they feel involved and could share their point of view on the product design and development. Dividing the groups into smaller groups and discussing the purpose of the platform and how it should be marketed was a way to gain fresh insights and new perspectives from different stakeholders (appendix 12).

Interaction enhances commitment and trust, which will lead to increased knowledge sharing by all the partners in the living lab. It also creates business opportunities for a lot of organizations in the living lab. The living lab coordinator illustrates:

"One of the goals of the living lab is to share as much knowledge possible and learn from each other. During the workshops, knowledge sharing is key and that every party has an equal voice. The breaks at the coffee machine are important for the organizations, because then business arrangements are made, outside the living lab."

In the Innovate Dementia living lab there is very little interaction with business stakeholders and in the Izi living lab there is almost no interaction in the living lab among stakeholders. Results show that this creates dissatisfaction among stakeholders and low commitment. A business stakeholder of the Innovate Dementia living lab illustrates:

"We didn't even get invited for the final delivery of the research. I had to approach the living lab myself, it felt a bit like they'd forgotten us sometimes."

One of the business stakeholders of the izi living lab says:

"We are in contact with the user ourselves and ask for their feedback. I'd expected that would be coordinated more from the Izi living lab, but we have to go to the user ourselves to collect feedback. Also, we are not cooperating with the knowledge institutions. I would have seen that as an added value of the living lab, if there would be some students who would collect additional feedback on our product. I think I would have felt more involved as well. Now we often only get a call when our product is defect. "

Too little communication and interaction with stakeholders, causes them to lean back which has a negative impact on the effectiveness and efficiency of the living lab innovation process. The Izi living lab coordinator says:

"We made a mistake by involving the stakeholders later on in the process and communicating too little. This results in stakeholders to sit back and not showing any intrinsic motivation. The living lab works good for small-scale projects such as technology testing, but not so much when we talk about collaborating to address a societal issue. The municipality is the demand side and has the budget and later on asked other parties to join. That is not co-creation. We don't have shared interests, ambitions or resources. That is what makes this process hard sometimes."

Frequency and stability of the relationships also impacts the continuity or sustainability of the living lab itself. In the Close-by living lab, stakeholders are co-creating for five years and it looks like the living lab is quite sustainable. The innovate Dementia living lab lasted for three years, because there were no sustainable relationships with business stakeholders. One of the coordinators declares:

"I think it is a pity that our living lab was not sustainable. Subsidy is not a sustainable way of collaborating. If you have business stakeholders who really value the living lab, you will see that sustainability exists. We made a mistake by not involving the business stakeholders as much as they'd liked because after the subsidy stopped, the living lab fell apart."

The Izi living lab coordinator declares:

"If we want the living lab to be sustainable we need to move to an approach in which a lot more collaboration takes place. In that way the municipality will not be responsible for the entire financing of the living lab, because we can't continue to pay for everything."

5.2.3 Spontaneity

	Methods used to gain insights into real-world context
Close-by	Interviews, focus groups, surveys
Innovate Dementia	Interviews, focus groups, diary study
Izi	Interviews, Ateliers, surveys

Table 8: Cross-case analysis spontaneity. Retrieved from appendix 11, 15 and 18

When comparing the living labs on how they collect their data to gain insights into the real world of the user, it is remarkable that all three living labs more or less use the same techniques. They all start by conducting interviews and surveys with individuals and elaborate on this information by discussing consistent subjects from the interview data in smaller focus groups. The researcher from the Innovate Dementia living lab declares:

"A mix of data collection methods was used to increase the validity of findings."

Off course different methods are used, such as the diary study in the Innovate dementia case, but those methods are specific for the user involved, in this case people living with dementia.

The Izi living lab and the Innovate dementia living lab agree on the fact that focus groups may negatively impact the effectiveness of the innovation outcome (physical innovation) or the effectiveness of the technology match (Izi).

"There were some elderly in the living lab that were more dominant than the other users. If he or she would act really enthusiastic about something other users will agree on that too. What we should have done is remove that person from the group so that other users would have their say. Therefore, interviewing individuals is often more valuable than co-creation sessions with multiple users."

On the other hand, both Izi and the Close-by living lab agree on the fact that a focus group is a mean for elderly to prevent loneliness participating in the living lab, which also is a problem among that target group. This however, is more a side-effect than that it impacts the living lab performance.

A difference between the cases is that the Close-by living lab and the Innovate Dementia living lab detect user needs prior to the innovation process, while the Izi living lab detects user needs in the last phases of the innovation process to match already existing technology with the needs of the user. As a result of

this, the living lab is often having trouble finding the right technology fit. The technology coordinator of Izi illustrates:

"It is often very hard to match the right technology with the needs of the elderly. First of all, we don't exactly know what is out there and they don't know either. And when we find something, it remains to be seen if these solutions are a good fit with the needs of the user."

5.2.4 Realism

	Contextual sphere	Different views taken into account	Users representative for target population
Close-by	5	5	5
Innovate Dementia	5	3	2
Izi	5	2	2

Table 9: Cross-case analysis Realism. Retrieved from appendix 11, 15 and 18

The way realism is practiced also varies among the different living labs. However, all three cases test their products in an environment that aims to be as realistic as possible: the user's home environment. By testing in an environment that is as realistic as possible, innovations are valid for real markets. The researcher of the Innovate Dementia living lab says:

"For the environment, we aim this to be as possible. As such, the studies have a high ecological validity and we learn faster how a certain innovation supports people living with dementia. Ecological validity will be higher, because the user will incorporate the technology into their daily routine."

The innovate dementia case and Izi case declare that testing in a real-life environment takes up a lot of time and is quite expensive. A business stakeholder in the Izi living lab illustrates:

"We could only produce a few prototypes, since they are quite expensive. This means you have to invest a lot of money and time in this operation. Deliver the prototype to a user, picking them up, delivering it to another user, coffee, cookies, etc. My agenda was overfull. "
Another negative impact on efficiency is when doing research, the control reduces. The researcher of the Innovate Dementia living lab explains:

"The challenge when innovating in a real-life context is that it is hard to do validated research, because you don't have all the factors of the research under control, like in a lab. Control reduces, when reality increases which makes it hard to generalize. It is hard to do measurements on effectiveness,

because someone might have a bad day or could be really happy because a lot of people visited him that day."

Or the other way around in the Close-by living lab, where efficiency was quite high since all users were in one space together in the beginning phase:

"If people would experience problems with the platform, for example down-time, it could be solved on-site by a technician present at the TU. All problems were written down and taken into consideration in the research. If people would test the platform in their homes and this would happen, we would have had a problem."

To address a problem, it is important to take multiple views into account. It is important for the effectiveness of the outcome to take different views into account during the innovation phase. Innovate Dementia only takes the user's view into account when it comes to the PHYCIAL and homing compass and suppliers in the Izi living lab take their own view into account and later on involve the user. Both approaches turn out to negatively impact the effectiveness of the innovation outcome.

The two innovations in the Innovate Dementia living lab (homing compass and PHYSICAL) that were built up from on the idea generation phase, failed in the market launch phase because business stakeholders were not involved from the beginning and the innovations were entirely based on the needs of the user. In other words, the living lab missed the knowledge of the industry in the beginning of the innovation process. One interviewee declares about the homing compass innovation:

"There is a mismatch between what an organization wants and what the user wants. If we would have worked with a company like TomTom from the beginning, we would have had a different design outcome, but the product would be on the market. I know that not everyone will agree on this, but in my opinion we should have included organizations from the beginning as designers, together with users."

As for the Close-by living lab, multiple stakeholder views are taken into account from the idea generation phase on; not only elderly and their informal caregivers but also business stakeholders. The living lab coordinator declares:

"This a societal problem that affects a lot of different parties in our society, which means we should look for solutions together. Every party has a different point of view, which makes it interesting and ensures that we learn from each other."

There should be a compromise between what the user wants and what a company wants. An interviewee from the Innovate living lab illustrates:

"The products that we developed without an organization are more user-friendly, but still stand on the shelf while the others are on the market. You have to balance between those different stakeholder groups."

Another factor that impacts the effectiveness of the outcome is what kind of users are used in the innovation process. If this group of users is not representative for the target population innovation outcomes may not fit the needs of the actual users or in the Izi case, research results will be useless. One of the business stakeholders in the Izi living lab says:

"The problem with the Izi living lab is that their users are too 'good' to test our product. Users were testing our walker, while they would normally not be using a walker. That makes no sense. It would be almost the same like if we would be testing the walker, it would only be in our way probably."

The researcher in the living lab also sees this as a problematic fact. Research is done on the effect of the use of technology the quality of life of the elderly. She declares:

"Elderly participating in the Izi living lab are old people who are enthusiastic about technology. If you only include this kind of users, it will probably be hard to get valuable outcomes when measuring the difference in quality of life over 1year time, because their quality of life is already quite good."

The Innovate Dementia living lab involved people with early mild-stage dementia, because they still have a sense of self. Moreover, the living lab had trouble attracting sufficient users in the living lab, which impacts the effectiveness of the living lab outcome.

"Finally, the limited number of participants questions the validity of our results. The study provided ample input for a qualitative refection of the evaluation game; however, concerning the effects of the intervention the numbers were too little for conclusive results."

As mentioned before, the Close-by living lab includes users from all different ages, backgrounds, gender, etc. But also from different stakeholder groups which positively impacted the living lab performance, because it meets the requirements of multiple parties.

5.2.5 Empowerment of user

	Innovation based on needs of the user	User involved throughout the entire process	Weight of the user's voice.
Close-by	4	5	4
Innovate Dementia	3	4	3.5
Izi	2	3	2

Table 10: Cross-case analysis empowerment of user. Retrieved from appendix 11, 15 and 18

Looking at the table above, the empowerment of the user varies among the three cases. All three living labs value the needs of the user, but there is a difference in how the user is involved in the innovation process. In the Close-by case the user is involved from the idea generation phase till market launch phase. This living lab is a user-driven living lab. On the contrary, in the Izi living lab users are involved in the product development or market launch phase. This living lab practices a user-centric open approach, were users have more influence in the development process, but are only involved in the process once. The Innovate Dementia case is somewhere in between by practicing a user-driven approach for the PHYSICAL and homing compass innovation and in some cases practicing a user-centric open approach, such as for Vitaallicht and the Golive phone.

In the Izi case, users were involved later on in the process. This means that the innovations were not highly based on the needs of the user. As a result, the innovations do not respond to the needs of the user or to the needs of the industry. An interviewee from the Izi living lab says:

"We have a lot of products that in terms of design, layout, communication and information, are too late involved in the co-creation process with the user. It is therefore often had for us to match the right technology with the right needs. Technology that we have in our living lab often doesn't replace, compensates or atomizes anything, which makes the matching even harder."

Empowerment of the user costs a lot of time, but the outcomes are highly effective because they meet the need of the user. The Close-by coordinator illustrates:

"When there is a high degree of co-creation with the user, a lot of iterations need to be done. It might not be very efficient but every input can immediately be validated and we can immediately respond to problems and tackle them. If we would not do this and just offer them a platform that doesn't meet their needs or desires, we have a serious problem."

Innovate Dementia and Close-by declare that doing research on- and innovate with elderly or people living with dementia delays the innovation process, because this target group is not familiar with technology and participation may be hard for them. One researcher illustrates in his dissertation:

"Another important insight from each of these studies is the concept of segmenting the research into smaller parts. It shows that this reduces the burden of participation of those with dementia. Also, you have to constantly adjust your research methods to the target group."

In the Izi living lab this is not the case and users are highly motivated to participate. This can be explained by the fact that mainly vital and energetic elderly participate in the living lab. Moreover, there is no high degree of co-creation with the end-user and there are hardly any design alterations and research iterations taken place, which positively impacts efficiency.

5.2.6   Network Governance

	Governance form	Roles & Responsibilities	Managing expectations	Goal consensus	Decision-making processes
Close-by	Provider-driven	5	5	4	4
Innovate Dementia	Provider-driven, shared governance	3	2	2	3
Izi	Enabler-driven	2	2	2	2

Table 11: Cross-case analysis network governance. Retrieved from appendix 11, 15 and 18

All three living labs are coordinated in a different way and by different stakeholders in the living lab. Results show that this impacts the participation in the stakeholder networks of living labs.

Close-by is a provider-driven living lab in which the researcher is the governing actor. In the Close-by living lab, the partners see the researcher as the right person to coordinate the living lab. One of the interviewees declares:

"A coordinator from a knowledge institution is in my opinion the best option for a living lab due to the fact that knowledge from the academic world can be used into practice right away. Moreover, the living lab coordinator does not have an economic interest."

The Innovate Dementia living lab could also be seen as a provider-driven living lab, although here governance is shared by the consortium members. The partners of the Innovate Dementia living lab are very satisfied with the governance structure because it enhances commitment and knowledge sharing: According to an interviewee:

"That really worked well, because every meeting would have different agenda's and points to discuss. You often see that if one party takes the lead, then other parties tend to sit back and just watch. Now that everyone had a say, the commitment was very high."

Nevertheless, business stakeholders were very dissatisfied with the governance structure, because they were not involved in the shared governance structure which made them feel left out and not committed. The Izi living lab is an enabler-driven living lab. The stakeholders within the living lab, including the municipality itself agree on the fact that a municipality might not be the best party as a coordinator. It impacts efficiency and intrinsic motivation of stakeholders.

"A municipality, in my opinion, should be part of a living lab but it is not their core business to organise a living lab. When stakeholders hear the word 'municipality', they tend to sit back and think 'o they will fix it'."

The municipality as a coordinator negatively impacts the efficiency of the innovation process. Another partner illustrates:

"An organisation such as the municipality is very slow. And when it comes to innovating, everything needs to happen in a fast pace. I think they are quite inexperienced when it comes to living labs and technology development, and therefore they cannot offer us the best support. "

Not only does the governing actor impact the participation of stakeholders, also the way in which the living lab is governed has an impact. Results show that when a living lab coordinator makes a clear division of roles and responsibilities that this will positively impact the efficiency of the innovation process. Management of expectations, goal consensus and involvement in decision-making processes positively impact stakeholder satisfaction and therefore, their intrinsic motivation to co-create and share knowledge in the living lab. When there is a high degree of co-creation, the living lab can really find solutions for society that are valid for real markets and meet the expectations of multiple stakeholders.

According to the stakeholders, the coordinators of the Innovate Dementia living lab and the Izi living lab did not have a clear vision or project management. There were no common goals, roadmaps, deadlines and no clear division of tasks. As a result, stakeholders are dissatisfied because the innovation process

does not live up to their expectations and the overarching goal to improve the quality of life of elderly or people living with dementia gets forgotten.

The Izi living lab also erected the living lab to support the elderly and increase their quality of life. But due to lack of project management in the living lab, the living lab now mainly acts as a test facility for suppliers to test and market their innovations. An interviewee from the Izi living lab declares:

"There is no overarching plan. Everybody is doing their own part in the living lab, there is no real co-creation. I notice that I feel frustrated about this, because people forget the bigger picture, the reason why I joined the living lab in the first place: to support the elderly."

6 Conclusion

In this section the propositions discussed in the theoretical framework will be revised and the research question will be answered. In the conceptual model, the effect of the living lab approach on living lab performance ought to be sought. Results show that each principle has a different effect on the living lab performance, and that often a principle has a different impact on the effectiveness and the efficiency of the living lab innovation process. Therefore, in this section, we will discuss every principle separately and its impact on different elements of the living lab performance.

Simultaneously, in this section we will answer the research question:

How should the key principles of the living approach be practiced in order to enhance the living lab performance, moderated by network governance?

In the previous section the differences and similarities in execution of the key principles were discussed and was indicated which approach worked best. Managerial recommendations for living lab coordinators will be given at the end of each section.

6.1 Propositions

6.1.1. Openness

> *P1: Openness has a positive effect on the living lab performance.*

According to the literature, openness will lead to increased knowledge and more rapid progress (Erikson et al. 2005), which benefits the living lab performance. Results show that when a living lab involves multiple stakeholders, with different backgrounds throughout the entire innovation process that this will positively impact the effectiveness of the living lab innovation process. The Close-by case has a lot of knowledge in its living lab and involves its stakeholders throughout the entire process. As a result, the living lab delivers an innovation that is useful for elderly, informal caregivers, organizations and municipalities. The Izi living lab does not involve the stakeholder group of care providers. Therefore, they miss important knowledge and resources within the living lab to address a societal issue.

If openness will positively impact the efficiency of the innovation process is questionable. The Close-by living lab has by far the most stakeholders. According to the living lab coordinator more knowledge from different parties accelerates the exploration of the platform's potential and therefore increases the efficiency of the innovation process. However, coordinating 21 stakeholders negatively impacts the efficiency since decision making processes go very slow. Especially being open to involving multinationals

results in less efficiency, due to people sitting at the table who are delegated by higher people in the organization and these kinds of organizations are too cumbersome to act rapidly.

Concluding from this, openness positively impacts the effectiveness of the living lab innovation process due to increased knowledge which leads to innovations that are beneficial for multiple stakeholders. It is not supported that openness positively impacts the living lab innovation process, because more knowledge does accelerate the innovation process, but involving too much stakeholders negatively impacts coordination efficiency. More evidence will be necessary to indicate whether openness positively or negatively impact the efficiency of the innovation process.

This will lead to the following relation:
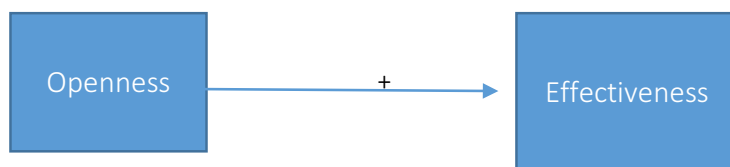
Figure 5: Impact Openness

Living lab coordinators should attract a high diversity of stakeholders to increase the knowledge in the living lab. However, they should be careful not to attract too many stakeholders which will result in a slow innovation process. Be open, but not too open. Make sure that you attract the right people in the organization. The higher the person in the organization, the faster the innovation process. The living lab should be open the entire process and gain a multitude of perspectives from the beginning in order for the living lab outcome to fit the needs of the user and other stakeholders the best. In the smart living innovation process, it is of essence to involve another stakeholder group: care institutions.

6.1.2. Continuity
P2: Continuity has a positive effect on the living lab performance.

According to the literature, continuity is important in a living lab in order to strengthen the innovation process and creativity (Corelabs, 2007). Results show that frequency of interaction and strength of relationships have a positive effect on co-creation within in living lab. In the Izi living lab, there is almost no interaction among stakeholders which results in low co-creation within the living lab. Frequent interaction among stakeholders enhances trust (Jones et al. 1997). Results also show that frequent interaction and transparency enhance commitment of the stakeholders, which results in knowledge

sharing and a multitude of perspectives on various elements of the innovation process. Frequent interaction and stability of relationships also positively impact the sustainability of the living lab looking at the Close-by living lab in which stakeholders co-create for already 5 years.

When interaction is low, stakeholders will not feel involved in the innovation process and are not intrinsically motivated to co-create. This results in a negative impact on the effectiveness and efficiency of the innovation process, because stakeholder tend to sit back.

Concluding from this, continuity positively impacts the effectiveness and efficiency of the innovation process due to increased knowledge sharing and commitment of the stakeholders involved.

This will lead to the following relations:
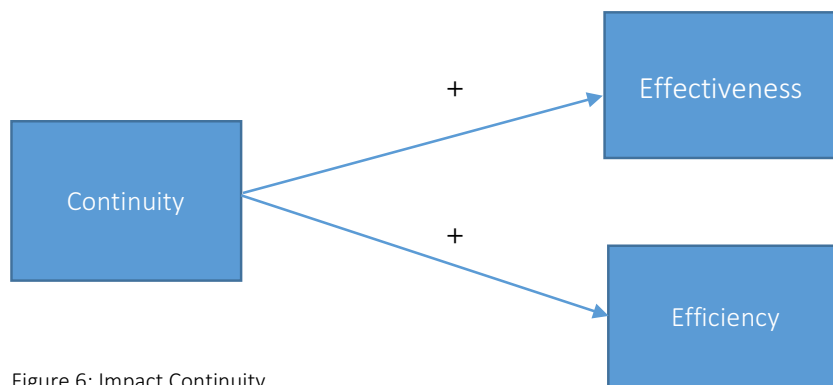
Figure 6: Impact Continuity

Living lab coordinators should facilitate sufficient meetings, communication tools, etc.to keep the innovation process transparent and allowing stakeholders to interact with each other. Make sure that not every party is just performing their own task assigned, but that there is real co-creation among stakeholders. This will lead to a more effective living lab outcome and more efficient process.

6.1.3. Empowerment of user

P3: Empowerment of users has a positive effect on the living lab performance.

According to the literature, users are a valuable source of information (Edwards-Schachter et al. 2012). Taking into account their needs and desires, will benefit the living lab performance. Results show that early involvement of the user in the process and the influence of the user's voice positively impact the effectiveness of the living lab innovation process. In the Izi living lab there is almost no co-creation with

the user and they are only involved in the development or market launch phase. As a result, it is hard to match technology with the needs of the user.

In addition, results show that the empowerment of the user negatively impacts the efficiency of the innovation process. Research iterations with the user take up a lot of time and costs, no to mention the constant adjustments of research methods to the target group. Especially involving elderly will delay the smart living innovation process, because elderly are often not familiar with technology use.

Concluding from this, empowerment of the user positively impacts the effectiveness of the innovation process, but negatively impacts the efficiency of the innovation process.

This will lead to the following relations:
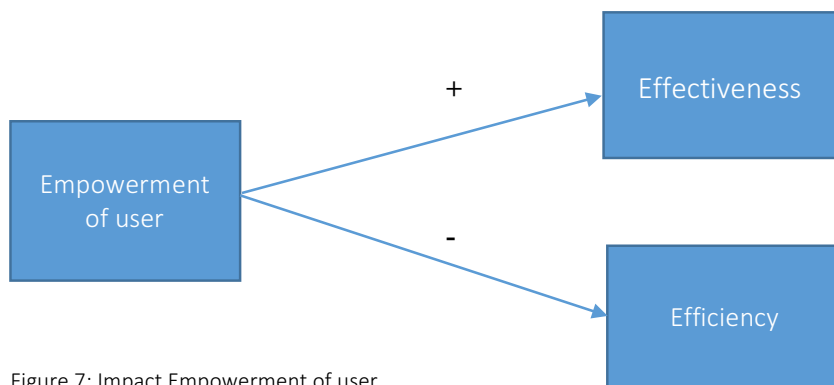
Figure 7: Impact Empowerment of user

Living lab coordinators should value the opinion of users in order to deliver more valuable innovations. However, too much empowerment of the user and neglecting other stakeholders, such as in the Innovate Dementia case, can negatively impact the effectiveness of the innovation process. Therefore, a trade-off should be made between the user's needs and other stakeholder's needs. It is possible that conflict will arise, but the living lab coordinator needs to find the right balance.

6.1.4. Realism

P4: Realism has a positive effect on the living lab performance.

According to the literature, practicing realism in a living lab will lead to innovations that are valid for real markets (Schumacher & Feurstein, 2007). The researcher of the Innovate Dementia living lab confirms this by saying that innovating in a real-life context increases the ecological validity of the study and one will learn faster on how the technology will support the user since the technology is incorporated into

their daily lives. As shown in the results, another very important element of realism, is the representativeness of the user for the target population. When users are 'too good' or the group of users is not large enough it will decrease the validity of the research and therefore the effectiveness of the innovation process, which was the case in the Innovate Dementia- and the Izi living lab.

Results show that realism negatively impacts the efficiency of the innovation process. Research will take more time, because a lot of factors are not under control when doing research. In addition, making a lot of prototypes often is expensive and moving them from one user to the other also takes up a lot of time.

Concluding from this, realism has a positive impact on the effectiveness of the innovation process due to increasing validity, but negatively impacts the efficiency of the innovation process due to loss of control in research and expensive prototypes that needs to be moved around.

This will lead to the following relations:
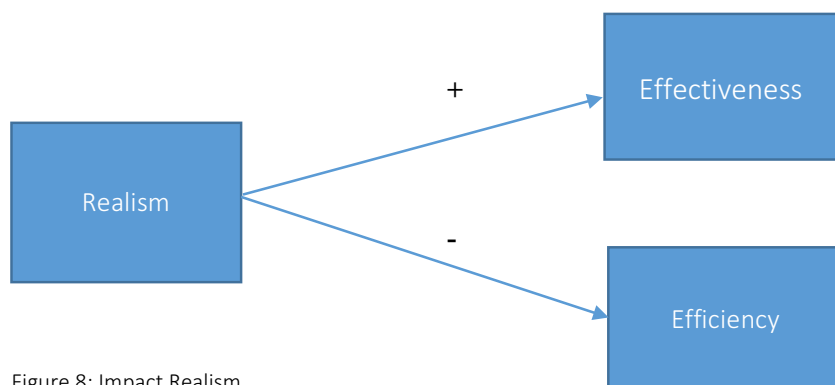
Figure 8: Impact Realism

Living lab coordinators should search for a test environment that is as realistic as possible, preferably in the user's home environment. It is of essence that the researcher in the living lab carefully selects its user group. Diversity in this group should be high (different age, gender, background, profession, etc.) and the test group should be large enough. If the living lab involves business stakeholders that already have a product or product idea for the living lab, prepare them for the possible high costs and duration of the innovation process.

6.1.5. Spontaneity

> *P5: Spontaneity has a positive effect on the living lab performance.*

According to the literature spontaneity is the ability to detect, aggregate and analyse the needs and ideas of users which is beneficial for the innovation outcome (Bergvall-Kåreborn et al. 2009). The methods used

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to gain insights into the user's real-life context are more or less the same across the cases (interviews, surveys and focus groups). It is hard to make a cross-case comparison, since all methods are more or less analogous. The difference however, could be found in the timing of the application of the research methods. While Close-by and Innovate Dementia living lab apply the spontaneity principle in the idea generation phase of innovation, the Izi living lab applies spontaneity in the product development or market launch phase. As a result, it is hard to match technology with the needs of the user. As you can see, this principle is almost the same as 'empowerment of the user' and therefore has the same impact on the effectiveness of the innovation process. Looking at the results, no evidence could be found on the impact of spontaneity on the efficiency of the innovation process. Presumably, it is the same as 'empowerment of the user', but there are no results to confirm this.

Concluding from this, spontaneity positively impacts the effectiveness of the innovation process, because the innovation will better match the needs of the user.
This will lead to the following relation:
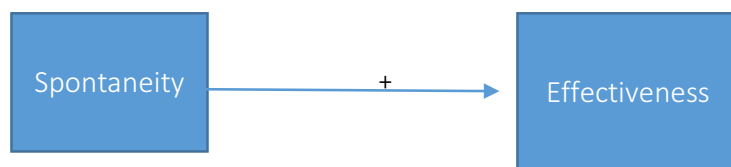
Figure 9: Impact Spontaneity

Researchers should use a variety of research methods to increase validity. It is of essence to do this in the beginning of the innovation process, so that the innovation fits with the needs of the user. When addressing complex societal issues such as an ageing population it is important to detect, aggregate and analyse the needs and ideas of multiple participants. An example is the Close-by case that also involved suppliers/organizations, municipalities, elderly, informal caregivers and professional caregivers.
Another very important recommendation for researchers in a living lab is that when one chooses to use focus groups, that some participants might dominate the other participants. This may have a negative impact on the effectiveness of the innovation process.

6.1.6. Network Governance

P6: Network governance moderates the relationship between the living lab approach and the living lab performance

The network of stakeholders is considered to be an essential part of living labs and so it is assumed in this research that the governance of the network moderates the relationship between the living lab approach and the living lab performance. Results show that the party governing the living lab impacts the relationship. In the enabler-driven living lab Izi, the living lab is based on the objectives and interests of the municipality. They have an economic interest: to create a joint infrastructure to pay for the changing legislation instead of seeing the user as the first priority. The overarching goal of enabling the user to live in their homes for as long as possible and to enhance their quality of life, is more or less forgotten. Resulting in a living lab that is useful for smaller projects, such as user inquiry tests but not for solving a societal issue. Moreover, stakeholders are less intrinsically motivated with the municipality as governing party and tend to sit back.

The two provider-driven living labs are more focused on the needs of the user, where in both living labs the researcher is the governing party or part of the shared governance. This positively impacts the overarching goal of improving the user's everyday life, since knowledge from the academic world can be used into practice right away and the objective of the living lab is not the interest of the governing party. A shared governance works well for small(er) living labs, because it increases commitment among participants. Nevertheless, it is important to involve all the stakeholders in this governance mode to increase effectiveness.

Apart from the governing party, it is also important how the living lab is governed. Results show that within the Close-by living lab commitment is really high, stakeholders are motivated to share their knowledge and resources and the goal to create an innovation that enables elderly to live in their homes longer is attained. Important governance factors are: clear division of roles & responsibilities, managing expectations, involvement in decision-making processes and goal consensus, which positively impacted the relationship. As for the Innovate Dementia and Izi living lab, the lack of project management and goal consensus negatively impacted the relationship between the living lab approach and the living lab performance.

Concluding from this, network governance impacts the relationship between the living lab approach and the living lab performance. Good network governance positively impacts the relationship between the living lab approach and the performance of the living lab, while weak network governance negatively impacts the relationship. Important variables of network governance that play a role in living labs are: a clear division of roles and responsibilities, managing expectations of the stakeholders, involvement in decision making processes and creating goal consensus. In addition, the party that coordinates the living

lab impacts the relationship. Results show that in these cases a provider-driven living lab positively impacts the relationships, while an enabler-driven living lab negatively impacts the relationship. Therefore, this will lead to the following relation:
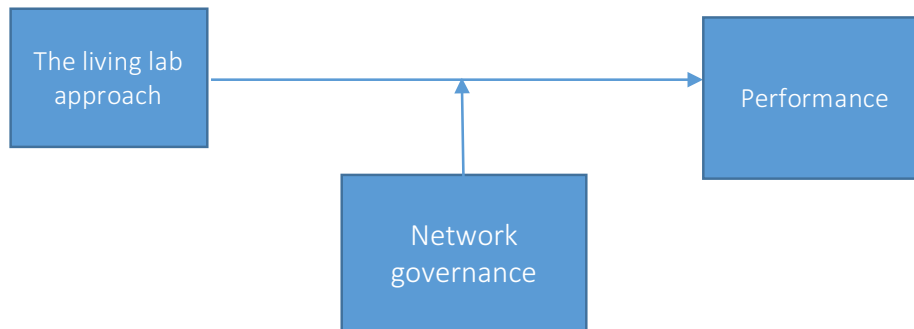

Figure 10: Impact Network governance

Living lab coordinators should govern the living lab like it is a project. Make a clear division of roles and responsibilities to enhance efficiency. Most important is to manage the expectations of the stakeholders in the living lab and make sure that the outcome is beneficial for everyone. Set up democratic decision-making processes, or be transparent about the decisions that you make and make sure that all stakeholders work together to attain a common goal. Stakeholder commitment is a very important factor that influences the performance of the living lab.

7 Discussion

This chapter will reflect on the findings in this research. First of all, the principles of the living lab approach will be discussed. Thereafter, the living lab approach as an innovation approach will be discussed. Finally, the limitations of this research will be discussed and implications for further research will be given.

7.1 Reflecting on the principles of the living lab approach

This explorative study gained insights into the living lab approach; how it is practiced among different cases and what the effects are on the smart living innovation process. Because of this scope, the external validity and generalizability of the results of this research is therefore slightly restricted.

Looking back on the literature (table 1), the principles 'spontaneity' and 'continuity' are not mentioned among the common elements mentioned in the living lab descriptions. The practicing of the principle spontaneity was hard to compare between the cases. To gain insights into the user's needs, more or less the same methods were used (interviews, surveys, and focus groups). Other methods used per case were specific for the scope of the case, for example using the diary study for people living with dementia. Looking at the principle itself, the principle strongly relates to empowerment of users since user's reactions can't be detected if the user is not involved. According to Ståhlbröst (2009), the principle relates strongly to the principle of openness and empowerment of user. She therefore argues, that this principle might not specifically contribute to the living lab approach. Although it may not specifically contribute to the living lab approach, doesn't mean that the principle is not important. Spontaneity cannot be practiced without openness or empowerment of the user, but that doesn't mean the living lab is able to detect, aggregate and analyse the needs and ideas of the user. The principle is needed to enhance creativity in the innovation process and to make sure that the innovation fits the needs of the user. Researchers should carefully choose their methods to detect ideas that are valuable for the innovation process. This study shows that focus groups are a valuable method of doing research and to increase validity. Nevertheless, when focus groups are dominated by certain users it could negatively impact the innovation process. Group influences may cause other users to be hesitant to express their thoughts and it can have inhibitory effects, like social desirability bias (Evers, 2007). The principle is important for living labs, but it is hard to tell how the principle should be practiced. Methods used are different for every living lab and depend on the goals of the project (Feurstein et al. 2008).

The principle continuity, also not really specific for the living lab approach according to other literature (table 1), turned out to be a very important principle. Continuity strengthens co-creation between the stakeholders in the living lab. Frequent interaction between stakeholders makes them feel involved and committed, which ensures knowledge sharing and positively impacts the innovation outcome. The Close-by living lab shows that with a high degree of co-creation, stakeholders within a living lab are able to develop innovations that address complex societal issues such as an ageing population, on national level. Frequent interactions between living lab partners also positively impact the continuity or sustainability of the living lab as a whole.

As you can see, both Spontaneity and Continuity are important for a living lab to practice, because they contribute to the creativity of the living lab, either from the user or from the stakeholders altogether.

As mentioned before, the living lab principles tend to overlap with each other. This makes it often hard to differentiate between them. Openness and Realism for example, both include the importance of a multitude of perspectives during the innovation approach and Spontaneity and Empowerment of user both underline the importance of using the ideas of the user in the innovation process. The principles are not very specific, which made it often hard to define them well. I suggest to make the principles more concrete by replacing them with four variables:

| Living lab network |
| Living lab network | The living lab approach |
| User involvement |
| Living lab environment |
| Living lab governance |
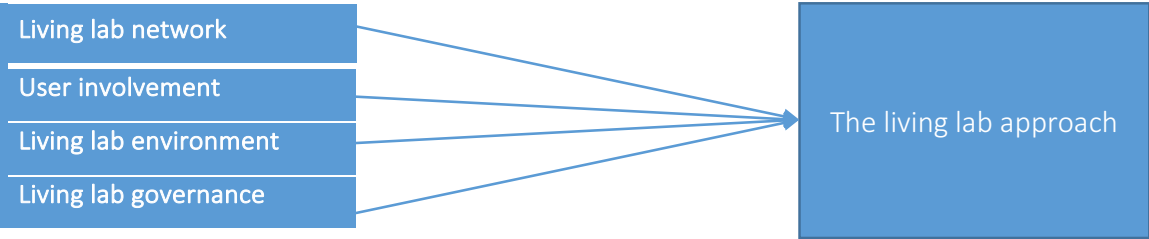
Figure 11: Suggestion for new living lab approach

These variables are still no guidelines for how a living lab should be set up or how they should be practiced, but they are more tangible compared to the principles of Ståhlbröst (2009). Continuity will be incorporated into living lab governance were the living lab coordinator will have to facilitate frequent interactions among stakeholders to build trust and Spontaneity will be incorporated into user involvement were the living lab should choose the right methods to detect, aggregate and analyse the needs and ideas of the user. Below, a table has been set up with important elements of the variables,

according to this research. As you can see, some elements are accommodated under another overarching variable. An example is 'user representative for target population' who used to be covered by the principle of realism (now: living lab environment), but is now moved to user involvement (previously: empowerment of user).

Living lab network	User involvement	Living lab environment	Living lab governance
Diversity of stakeholders	User involved in every phase	Realistic as possible	Managing expectations
Take different views into account	User representative for target population		Clear roles & responsibilities
Moderate amount of stakeholders	Research methods adapted to target group		Creating goal consensus
Involve stakeholders throughout entire process	Research iterations with user		Democratic decision-making processes
Involve right people in the organization			Facilitate stakeholder interactions
			Create transparency in the innovation process

Table 12: Important elements of the living lab approach according to this research

7.2 Reflecting on the living lab approach as innovation approach

The comparative study shows that all three living labs practiced the living lab approach in a very different way and have different purposes. The living labs are either used for design purposes or user inquiry, or both. It is acknowledged by the literature that living lab can be used for a broad variety of activities such as creating, prototyping, validating and testing (Mulder et al. 2008; Westerlund & Leminen, 2011; Guzman et al. 2013).

The phenomenon 'living lab' should not be seen as an arena or entity, but rather as an innovation approach. This research shows that when all the principles of the living lab approach are practiced to great extent altogether, the living lab will have the highest performance and societal problems could be addressed. Practicing the living lab principles will increase the effectiveness of the innovation process by delivering innovations that meet the needs of the user and are valid for real markets. In this research we can see a relation between practicing the living lab principles and the purpose of the living lab. The greater the extend to which the living lab principles are practiced the more likely it is that the living lab engages in new product development (NPD). As it declines, the more likely it is that the living lab engages in user inquiry or 'validating and testing'.

Insights were gained on the efficiency of the innovation process on which the living lab approach often has a negative impact. Due to the many iterations in research, empowerment of the user, innovating in a real-life context and involving multiple stakeholders the innovation process costs a lot of time. This often causes dissatisfaction among (business) stakeholders, who want to innovate in a fast pace and don't see the innovation process of living labs as an agile way of working. Organizations often don't have the time and financial resources to participate in an innovation process of about five years. Example from the Close-by living lab: "*In my opinion this innovation process is very slow. Everything is researched exhaustively and it is not an agile way of working.*"

Living labs should not only be addressed to as an innovation approach, but also as an innovation network. Stakeholder satisfaction or stakeholder engagement turned out to be a very important element in living labs. In the first place, stakeholder satisfaction was included in the research as a performance metric, together with effectiveness and efficiency. As it turned out, stakeholder satisfaction is a result of frequent interaction and trust (continuity) and good network governance and causes the innovation process to be more efficient and effective because stakeholders are feeling intrinsically motivated to cooperate and co-create. This research found some important recommendations for stakeholder satisfaction and stakeholder engagement, which are compatible with the findings in Paskaleva et al. 2015. Involve all stakeholders from the beginning of the innovation process. The Innovate Dementia case and Izi living lab did not involve stakeholders from the beginning, which negatively impacted co-creation. It is important to understand their needs and desires from the beginning and build mutual trust (Paskaleva et al. 2015). It is important to prepare them in advance for the long innovation process, to avoid impatience and dissatisfaction. In addition, involve stakeholders with different backgrounds and competencies. For stakeholders, living labs have tangible and intangible outcomes (Leminen et al. 2012). Involving a high diversity of stakeholders, increases stakeholder satisfaction, because organizations can learn from each other and reciprocal agreements can be made outside the living lab. Living labs facilitate interactions between stakeholders in which they can increase their own potential by collaborating with different parties (Paskaleva et al. 2015). As one of the stakeholders in the Close-by living lab illustrates: "*At one point I really wanted to get together with ICTU to talk about blockchain, well the living lab coordinator fixt that for us.*" This was not related to the living lab activities.

As mentioned before, in the Close-by living lab case, it is important to identify how the living lab is beneficial for different stakeholders and to keep these goals sharp. According to Paskaleva et al. (2015), the level of engagement rests upon how beneficial the outcomes are for the stakeholder involved. In the Innovate Dementia case, research interests were considered more important than the interests of the

business stakeholders, which led to high dissatisfaction among business stakeholders. Finally, the moderator network governance turned out to be a large influence on the relationship between the living lab approach and the living lab performance. Governance structures and mechanisms need to be in place from the beginning of the innovation process. Shared objectives need to be created and clear vision and plan to co-create (Paskaleva et al. 2015). In this research important governance mechanisms were: clear division of roles and responsibilities, management of expectations, creating goal consensus, involvement in decision making processes and providing transparency in the innovation process.

In my opinion, living labs are a good method for finding solutions to address the societal problems of an ageing population. It appeared from the interviews that innovations in healthcare take a very long time and often fail (Herzlinger, 2016). Business stakeholders might see living labs as an inefficient innovation method, but without a living lab approach it might even take longer. Naturally, one can test products in a lab environment which would speed up the innovation process, but the outcomes are less valid for real markets and might fail in the market launch phase. As you can see from the results, empowerment of the user and testing in a real-life context are very important aspects for the innovation outcome to succeed and really meet the needs of the user. In addition, there are many stakeholders in the healthcare sector or elderly care that each have a different agenda and needs. Bringing them together in a living lab will give the best insights and will lead to innovations that fit the needs of multiple stakeholders, such as the healthcare platform of Close-by. The coordinator, also researcher of the Close-by living lab illustrates:
"If you want to innovate fast I would advise you not to do it in a living lab. But the knowledge sharing is so important. Put all your stakeholders in one room, then you will get the best insights."

There is still no consensus on the concept of living labs. Preliminary research on the phenomenon of living labs showed, that many institutes have the urge to call themselves a living lab when there is a user involved who test a product. Often, they are rather a 'test facility' in which organizations can test their products and collect feedback from the user. Living labs should be seen as an innovation approach and not just as a 'lab that lives' in which users test products in their home environments. In my opinion, one can call itself a 'living lab' when there is a user-driven co-creation process with multiple stakeholders in a real-life context to develop new products or services to address societal problems. In which the co-creation process is important and distinguishing from other innovation approaches.

Finally, when organizing a living lab aimed at innovations that benefit the user it is advisable to choose a provider-driven living lab approach. Utilizers and enablers usually have a more economic interest and the living lab will be based on their objectives instead of the user's, like in the Izi living lab.

7.3 Limitations

Some limitations should be addressed to this study. During this research it became evident that there is still no consensus on the concept 'living lab', which made the selection of cases and interviewing participants a difficult task. While going further in-depth into the cases it turned out that the Izi living lab does not see the concept as an innovation approach, but rather as an innovation arena or environment. Although they refer to themselves as a 'living lab' they are rather a 'test facility', since there is no co-creation with different stakeholders and hardly with the end-user. Even though this provided interesting insights, it can be seen as a limitation of the study since 'the living lab approach' was the research scope.

Apart from lack of consensus, the phenomenon 'living lab' is rather complex due to different interpretations and many factors to be taken into account. There is a high diversity among living labs in the Netherlands; different goals, different views, different designs, etc. Therefore, it is hard to make a good comparison between different living labs.

Furthermore, this research had a rather small sample size. It only included three living labs in the Netherlands. In addition, these living lab were aimed at smart living innovations, so the generalizability of results reduces when considering the living lab approach in general.

There is also a limitation regarding the reliability of results. While conducting interviews I noticed that a lot of respondents were a bit hesitant to talk about the organization of the living lab and especially about barriers or things that could be improved in the living lab. Coordinators felt the urge to promote their living lab and other respondents were a bit hesitant to talk about other stakeholders in the living lab in a negative way.

7.4 Further research

Additional research is needed on the concept 'living lab' to create more consensus and provide insights and recommendations for living lab coordinators who are setting up a living lab. First of all, the living lab approach should be studied in different contexts. The focus of this research were living labs aimed at smart living innovations. Nevertheless, living labs are a mean for all sorts of societal problems like

education or infrastructure. Maybe the living labs in different contexts can learn from each other. It would also be interesting to broaden the scope even further to living labs abroad and make a comparison. To go further in-depth on the living lab approach it is advisable to research each key principle separately to gain more knowledge on how they are practiced and to constitute a clearer description of the principles. It would also be interesting to compare living labs with case studies of other innovation approaches with a similar goal or purpose.

References

Alam, M. R., Reaz, M. B. I., & Ali, M. A. M. (2012). A review of smart homes—Past, present, and future. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, *42*(6), 1190-1203.

Alcotra, I. (2011). Best practices database for Living Labs: overview of the Living Lab approach; Living Lab best practice database specification. *Innovation Alcotra, Deliverable*, *2*

Almirall, E., Lee, M., & Wareham, J. (2012). Mapping Living Labs in the Landscape of Innovation Methodologies.

Arnkil, R., Järvensivu, A., Koski, P., & Piirainen, T. (n.d.). Exploring Quadruple Helix Outlining user-oriented innovation models.

Ballon, P., & Schuurman, D. (2015). Living labs: concepts, tools and cases. *Info*, *17*(4), info–04–2015–0024.

Bergvall-Kåreborn, B., Eriksson, C. I., Ståhlbröst, A., & Svensson, J. (n.d.). A Milieu for Innovation – Defining Living Labs.

Bergvall-Kåreborn, B., Ståhlbröst, A., Living Lab -An Open and Citizen-Centric Approach for Innovation. *International Journal of Innovation and Regional Development*.

Brown, S. (2010). Likert scale examples for surveys. *ANR Program evaluation, Iowa State University, USA*.

Butterfield, K. D., Reed, R., & Lemak, D. J. (n.d.). An Inductive Model of Collaboration From the Stakeholder's Perspective.

Carayannis, E. G., & Rakhmatullin, R. (2014). The Quadruple/Quintuple Innovation Helixes and Smart Specialisation Strategies for Sustainable and Inclusive Growth in Europe and Beyond. *J Knowl Econ*, *5*, 212–239.

Chan, M., Eve, D., Escriba, C., & Campo, E. (n.d.). A review of smart homes—Present state and future challenges.

CoreLabs (2007). Living Labs roadmap 2007-2010: recommendations on networked systems for open user-driven research, development and innovation', Luleå University of Technology, Centrum for Distance Spanning Technology

Cossetta, A., & Palumbo, M. (n.d.). The Co-production of Social Innovation: the case of Living Lab.

Dekkers, R. (2011). Perspectives on Living Labs as innovation networks. *International Journal of Networking and Virtual Organisations*, *9*(1), 58-85

Greve, K., Martinez, V., Jonas, J., Neely, A., & Möslein, K. (2016). Facilitating co-creation in living labs: The JOSEPHS study.

Greve, K., Martinez, V., & Neely, A. (n.d.). Bridging the Co-creation Gap Between Co-creators, Companies and Living Lab.

Guzmán, J. G., del Carpio, A. F., Colomo-Palacios, R., & de Diego, M. V. (2013). Living labs for user-driven innovation: a process reference model. *Research-Technology Management*, *56*(3), 29-39.

Harrell, M. C., & Bradley, M. A. (2009). *Data collection methods. Semi-structured interviews and focus groups*. Rand National Defense Research Inst santa monica ca.

Herzlinger, R. E. (2016). Why innovation in health care is so hard. *Harvard business review*, *84*(5), 58.

Hribernik, K. A., Thoben, K.-D., Schumacher, J., Vorarlberg, F., Feurstein, K., Hesmer, A., … Schumacher, J. (2008). Living Labs – A New Development Strategy Living Labs: A New Development Strategy.

Huizingh, E. K. (2011). Open innovation: State of the art and future perspectives. *Technovation*, *31*(1), 2-9.

Jones, C., Hesterly, W. S., & Borgatti, S. P. (1997). A general theory of network governance: Exchange conditions and social mechanisms. *Academy of management review*, *22*(4), 911-945.

Kenis, P., & Provan, K. G. (2008). TOWARDS AN EXOGENOUS THEORY OF PUBLIC NETWORK PERFORMANCE.

Kviselius, N. Z., Andersson, P., & Ozan, H. (2009). Living Labs as Tools for Open Innovation. *COMMUNICATIONS & STRATEGIES*, *2*(74).

Leminen, S., Westerlund, M., & Nyström, A.-G. (2012). Living Labs as Open-Innovation Networks.

Levén, P., & Holmström, J. (2008.). Consumer co-creation and the ecology of innovation: A living lab approach.

Maas, T., van den Broek, J., & Deuten, J. (2017). Living labs in Nederland: van open testfaciliteit tot levend lab.

Martin, S., Kelly, G., George Kernohan, W., McCreight, B., & Nugent, C. (2008). Smart home technologies for health and social care support (Review).

Mulder, I., Velthausz, D., & Kriens, M. (2008). THE LIVING LABS HARMONIZATION CUBE: COMMUNICATING LIVING LABS' ESSENTIALS, *10.*

Ni, Q., García Hernando, A., & de la Cruz, I. (2015). The Elderly's Independent Living in Smart Homes: A Characterization of Activities and Sensing Infrastructure Survey to Facilitate Services Development. *Sensors*, *15*(5), 11312–11362.

Niitamo, V.-P., Westerlund, M., & Leminen, S. (2012). A Small-Firm Perspective on the Benefits of Living Labs.

Nyström, A.-G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), 483–495.

Paskaleva, K., Cooper, I., Linde, P., Peterson, B., & Götz, C. (2015). Stakeholder engagement in the smart city: Making living labs work. In *Transforming City Governments for Successful Smart Cities*.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. SAGE Publications, inc.

Provan, K. G., & Kenis, P. (2007). Modes of Network Governance: Structure, Management, and Effectiveness. *Journal of Public Administration Research and Theory*, *18*(2), 229–252.

Rijksoverheid.nl. (2015). Decentralisatie van overheidstaken naar gemeenten. [online] Available at: https://www.rijksoverheid.nl/onderwerpen/gemeenten/decentralisatie-van-overheidstaken-naar-gemeenten [Accessed 17 Feb. 2018].

Ritchie, J. (1994). Spencer, l.(1994). Qualitative data analysis for applied policy research. *Bryman and Burgess (Eds.), Analysing Qualitative Data*, 173-194.

Sanders, E.B.-N. (2002) From User-Centered to Participatory Design Approaches. In Frascara, J. (ed.) Design and the Social Sciences: Making Connections. Taylor & Francis, London, pp. 1–8.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). LNCS 6656 - Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation. *Future Internet Assembly LNCS*, *6656*, 431–446.

Schumacher, J. (n.d.). Deliverable 3.1 – abridged version and other good practices Alcotra Innovation project: Living Labs Definition, Harmonization Cube Indicators & Good Practices.

Schumacher, J., & Feurstein, K. (2007, June). Living Labs-the user as co-creator. In *Technology Management Conference (ICE), 2007 IEEE International* (pp. 1-6). IEEE.

Schuurman, D., Baccarne, B., De Marez, L., Veeckman, C., & Ballon, P. (2016). Living Labs as open innovation systems for knowledge exchange: solutions for sustainable innovation development. *Int. J. Business Innovation and Research J. Business Innovation and Research*, *103*(23), 322–340.

Schuurman, D., & De Marez, L. (2012). Structuring User Involvement in Panel-Based Living Labs.

Schuurman, D., De Marez, L., & Ballon, P. (2016). The Impact of Living Lab Methodology on Open Innovation Contributions and Outcomes. *Technology Innovation Management Review*, *6*(1).

Sgier, L. (2012). Qualitative data analysis. *An Initiat. Gebert Ruf Stift*, 19-21.

Solaimani, S., Keijzer-Broers, W., & Bouwman, H. (2015). What we do–and don't–know about the Smart Home: an analysis of the Smart Home literature. *Indoor and Built Environment*, *24*(3), 370-383.

Srivastava, A., & Thomson, S. B. (2009). Framework analysis: a qualitative methodology for applied policy research.

Steen, K., & van Bueren, E. (2017). The defining characteristics of urban living labs. *Technology Innovation Management Review*, *7*(7).

Ståhlbröst, A. (2012). A set of key principles to assess the impact of Living Labs. *International Journal of Product Development*, *17*(1-2), 60-75.

Ståhlbröst, A., Bergvall-Kåreborn, B., & Eriksson, C. I. (2015). Stakeholders in Smart City Living Lab Processes.

Veeckman, C., Schuurman, D., Leminen, S., & Westerlund, M. (2013). Linking Living Lab Characteristics and Their Outcomes: Towards a Conceptual Framework.

Welfens, M. J., Liedtke, C., Rohn, H., & Nordmann, J. (2010). Living Lab: Research and development of sustainable products and services through user-driven innovation in experimental-oriented environments.

Westerlund, M., & Leminen, S. (2011). Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs.

Yin, R. K. (n.d.). CASE STUDY RESEARCH Design and Methods Second Edition.

Appendices

Appendix 1 -The smart city

Source: Amsterdam Smart city 2018
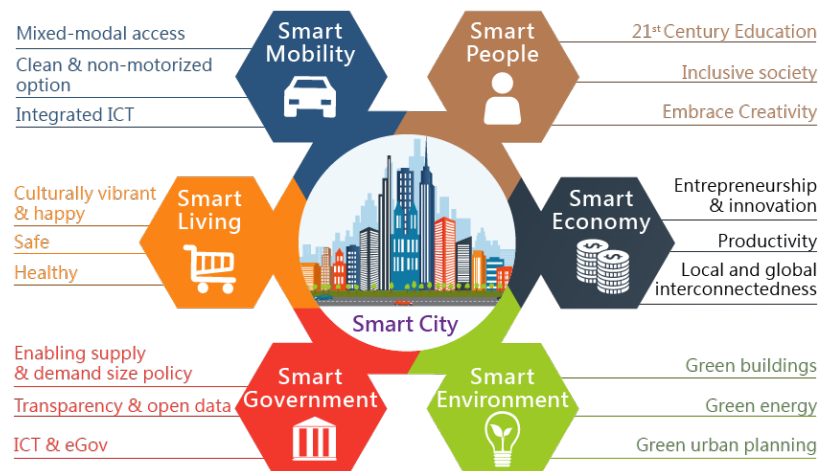
Appendix 2 -Stakeholder contribution in living labs in the Netherlands

Source: Rathenau institute (2017)

Type deelnemer	Percentage
Kennisorganisaties	
Universiteit	55%
Hogeschool	35%
Publieke Kennisorganisatie	27%
Bedrijven	
Grootbedrijf	49%
Midden- en kleinbedrijf (MKB)	53%
Overheid	
Rijksoverheid	10%
Provincie	12%
Regionale Ontwikkelings-maatschappij/Economic Board	9%
Gemeente	64%
Maatschappelijke partijen	
Burgerinitiatief	3%
NGO	16%
Overig	21%

Appendix 3 – Customer integration methods

Source: Schumacher & Feurstein, 2007

Product/Service Idea	Product/Service Concept	Product/Service Development	Market Launch
Traditional Methods: _Customer complaints _Interviews _Focus Groups _Empathic Design _Participatory Design _Story Telling _Customer Suggestions _Idea Generation with Lead-Users _Creativity Groups **CWE Methods:** _Online Interviews _Online Focus Groups _Online Suggestion Box _Online Creativity Groups _Market Intelligence Service	**Traditional Methods:** _Conjoint Analysis _Quality Function Deployment _Concept Tests with Lead Users **CWE Methods:** _web-based Conjoint Analysis _User Design	**Traditional Methods:** _Workshops with Customers _Prototype Testing _Usability Tests _Field Trials _Engineering Contests **CWE Methods:** _Dynamic Social Network logging _Experience Sampling Method _Virtual Prototype Tests _web-based CAD _User Toolkits	**Traditional Methods:** _Product Testing _Test Markets _Usability Tests **CWE Methods:** _Eyetracking _Time-motion-studies _Virtual Product Tests _Virtual Test Markets _Virtual Prototype Tests

Appendix 4 – Case selection

Smart-living living labs according to the Rathenau institute (2017)

Name	City	Description of living lab	Case selection
Innovate Dementia Living Lab	Eindhoven	*To cooperate with various stakeholders to develop assistive technology and services that contribute to the lives of people living with dementia. The aim is to allow them to live longer in the home environment, with an optimal quality of life*	Approved. Case will be used for research
Proeftuin High Tech Care & Cure	Eindhoven	*Within this living lab, the actors exchange ideas and knowledge in order to product products that enable people to receive healthcare treatment in their home environment. This will alleviate pressure on clinical treatments in the future.*	Not approved. The end-user is not involved in the innovation process.
Amstelhuis - Living Lab	Amsterdam	*Collaboration of the HvA and het Amstelhuis (facilities for elderly)*	Not approved. No technology solution
Leidse Proeftuin Zorg & Welzijn	Leiden	*This living lab is unique in the Netherlands and Europe, because it includes a novel way to enhance (health)care, by combining 'Leidse knowledge' with the demand of civil society.*	Not approved. No technology solution
Proeftuin Maastricht sociaal domein	Maastricht	*Social actors collaborate to find initiatives to make citizens more autonomous by preventive action.*	Not approved. No technology solution
Living lab zo-dichtbij	Rotterdam	*This initiative arises from a 3 year PhD investigation at the TU Delft. They are currently developing a healthcare platform to enable elderly to live in their home environment as long as possible and to unburden the informal caregiver.*	Approved. Case will be used for research

Appendix 5 – Case selection

Smart-living living labs according to internet search

Name:	City:	Description:	Case selection:
Age-friendly Amsterdam	Amsterdam	*The aim of the project is to create an age-friendly Amsterdam for all groups of older adults, and to involve them throughout the process. Older adults are therefore invite to participate co-researchers, alongside professionals.*	Not approved. No technology solution
Dementia friendly shopping	Amsterdam	*Enabling people with dementia to go outside and do some shopping (getting exercise) without losing the way. Creating a dementia friendly neighborhood.*	Not approved. No living lab
Co-Care-IT	Amsterdam	*Co-Care-IT focuses on the iterative development of an interactive platform to help mitigate the care burden of informal caregivers. User-Centred Design is central to this project.*	Not approved. No business stakeholders involved
Izi Gezond lang thuis	The Hague	*Technological innovations that enable elderly to live at home as long as possible, such as robots and motion sensors.*	Approved. Case will be used for research
Medical Delta Living Lab Care Robotics.	Delft	The focus of this living lab is aimed at care robots for a 'vulnerable' audience such as elderly with mobility issues.	Not approved. Living lab only 1 year in progress

Appendix 6 - Interview guide

General
1. Can you tell me something about the living lab? (purpose, goals, etc.)
2. Can you tell me something about your role in the living lab?

Openness
1. Which stakeholders participate in the living lab and what are their responsibilities?
2. In which processes were different stakeholders involved? (idea generation – market launch)
3. Where you satisfied with the composition of the network? (improvements, etc)
4. What did each stakeholder contribute to the living lab?

Continuity
1. Can you tell me something about the interaction between stakeholders? (meetings, communication, etc.)
2. Can you tell me something about the stability of the relationships? (contracts, duration, etc.)
3. Can you tell me something about the communication in the living lab?
4. What went well in the collaboration between stakeholders? What causes this?
5. What didn't go well in the collaboration? What causes this?

Empowerment of user
1. How is the end-user involved in the innovation process?
2. What went well in the innovation process with the user?
3. What didn't go well in the innovation process with the user?

Realism
1. Can you tell me something about the context in which the innovation process takes place?
2. Which stakeholders were involved in the development process?
3. Can you tell me something about the end-user involved?
4. What went well in this process?
5. What didn't go well in this process?

Spontaneity
1. How are insights obtained into the context of the end-user and their needs?
2. Which methods and tools are used?
3. What went well in this process?
4. What didn't go well in this process?

Governance
1. Which party governs the living lab?
2. Do you think that party is the best party to govern the living lab? Why?
3. Can you tell me something about the coordination/management of the living lab? What is your opinion about this?
4. How are decisions made in the living lab?

End
1. Are you satisfied with the (possible) outcome of the living lab?
2. What was the most challenging within the living lab?

R: Ik denk dat als bewoners een nachtje kunnen blijven slapen, dat is al anders. Dan ga je een stapje richting... Je moet het eigenlijk niet zien als dit is een living lab en dit niet. Je moet het eigenlijk als een sjaal zien van la omgeving tot de zo natuurlijk mogelijke omgeving en aan het einde van het spectrum zit dus ergens living labs. Je zou kunnen zeggen als je daar blijft slapen dan ben je niet altijd bezig met onderzoek, maar ook met je routines en dan kan ik me voorstellen dat dat al meer richting een hoger ecologische validiteit gaat. Een stapje verder nog is het echt bij mensen thuis plaatsen. De uitdaging is, hoe meer naar de realiteit gaat als je die schaal hebt, hoe moeilijker het is om gevalideerd onderzoek te doen. Je hebt namelijk niet alle factoren onder controle. Hele lage tot hele hoge controle dan zie je gewoon een lijn er tussen ontstaan, over dat de controle dus eigenlijk afneemt hoe realistischer onderzoek je gaat doen.

07:32 S: En wat voor effect heeft dat dan? Duurt het proces dan langer? Omdat je die controle dan niet meer hebt?

R: In een lab heb je alles onder controle, daar heb je alle variabelen. Dus je kunt makkelijk generaliseren. Als je heel veel factoren niet onder controle hebt dan kun je heel veel leren over hoe je product gebruikt zal worden, maar een effect meting wordt al lastiger. Om echt feitelijk te zeggen dit onderdeeltje van dit ontwerp van deze technologie heeft gezorgd dat dit er kwam. Misschien heeft iemand een slechte dag. Misschien komen er wel heel veel mensen op bezoek en is iemand blij. Je kan het moeilijker attributeren aan de interventie die je dan plaatst.

S: Het is dan denk ik wel makkelijk om te zien hoe zij met zo'n product om te gaan.

R: Ja dus voor het bedrijfsleven lijkt me dat veel waardevoller. Om op die manier onderzoek te doen.

08:33 S: En hoe hebben jullie dat bij de innovatie dementia case gedaan?

R: Ja, het living lab dat we hebben ingericht daar, was als het ware achter de voordeur van mensen met dementie. Dus we hebben daar het onderzoek gedaan, dat zijn ook de cases die je hier inzitten. Dat waren 4 hoofdcases, maar naast deze 4 hoofdcases, is er ook studentenwerk onder het living lab geschaald. We hebben bijvoorbeeld ook focusgroep bijeenkomsten gehouden bij GGZ-E. Als onderdeel van het ontwerptraject eigenlijk, om dus een ontwerp keuze te kunnen maken, maar ook om inzicht te krijgen in de behoefte van mensen met dementie. Op een gegeven moment hebben we eigenlijk het hele project living lab genoemd, maar voor mij was dat eigenlijk alleen het onderzoek wat achter de voordeur gebeurde. Dus met de eindgebruiker. Dus je ziet, wij hebben bijvoorbeeld die kalender, je ziet hem hier nog staan, die is nu stuk. Daar hebben we in 2014 de eerste studie meegedaan. Deze hebben we met een laag aantal users achter de voordeur getest. Als je het echt met mensen in het veld wil doen dan betekent dat, dat je of het prototype moet verslepen of dat je een kleine serie moet maken. En dat is gewoon wel een uitdaging.

10:04 S: En wat hebben jullie gedaan dan?

R: Deze hebben we verplaatst en we hebben ook een smartphone interventie. Van deze interventie hadden we er vier. Kleine serie, die lamp was dat. Die hebben we uiteindelijk volgens mij bij 15 mensen getest. Zo hebben we eigenlijk steeds gekeken naar hoe kunnen we op een natuurlijke manier onderzoek doen achter de voordeur. En dit laatste stuk gaat meer over een aantal studentencases en een case meer in de buitenomgeving.

◇ Living lab concept
◇ Realism - Efficie...
◇ research conte...
◇ Realism - Efficiency
◇ research context
◇ Methods used
◇ Living lab c...
◇ Realism
◇ researc...
◇ Target population
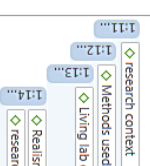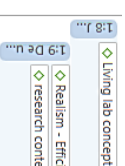
Appendix 8 – Second order codes

Name	Grounded	Density	Groups	Created by	Modified by
stakeholder involvement	28	0	[Openness]	10745351	10745351
interaction among stakeholders	17	0	[Continuity]	10745351	10745351
Financial arrangements	16	0	[Other]	10745351	10745351
Roles & Responsibilities	15	0	[Network governance]	10745351	10745351
user involvement	15	0	[Empowerment of user]	10745351	10745351
Living lab goal	14	0	[Living lab general]	10745351	10745351
Openness - effectiveness	11	0	[Openness]	10745351	10745351
Continuity	10	0	[Continuity]	10745351	10745351
Coordination	9	0	[Network governance]	10745351	10745351
Living lab concept	9	0	[Living lab general]	10745351	10745351
Target population	9	0	[Realism]	10745351	10745351
research context	8	0	[Realism]	10745351	10745351
Stakeholders	7	0	[Openness]	10745351	10745351
Realism-effectiveness	7	0	[Realism]	10745351	10745351
Methods & Tools	6	0	[Spontaneity]	10745351	10745351
managing expectations	6	0	[Network governance]	10745351	10745351
Trust	6	0	[Continuity]	10745351	10745351
Innovation based on needs user	6	0	[Empowerment of user]	10745351	10745351
Effectiveness	6	0	[Other]	10745351	10745351
Realism - Efficiency	5	0	[Realism]	10745351	10745351
Diversity of stakeholders	5	0		10745351	10745351
Empowerment of user - efficiency	5	0	[Empowerment of user]	10745351	10745351
Weight of user's voice	5	0	[Empowerment of user]	10745351	10745351
living lab outcome	4	0	[Living lab general]	10745351	10745351
stakeholder satisfaction	4	0	[Other]	10745351	10745351
Composition of the network	4	0	[Openness]	10745351	10745351
Different stakeholder views	4	0	[Realism]	10745351	10745351
Governance - effectiveness	3	0	[Network governance]	10745351	10745351
listen to users	3	0	[Empowerment of user]	10745351	10745351
living lab phase	3	0	[Living lab general]	10745351	10745351
Openness-efficiency	3	0	[Openness]	10745351	10745351
Amount of prototypes	3	0	[Realism]	10745351	10745351
Efficiency	3	0	[Other]	10745351	10745351
Living lab scaling	3	0	[Living lab general]	10745351	10745351
Governance mode	3	0	[Network governance]	10745351	10745351
user diversity	2	0	[Realism]	10745351	10745351

Appendix 9 - Close-by innovation

Appendix 10 - Living lab partners Close-by

Stakeholder group	Partner	Role in the project
Academia	TU Delft	3 year PhD research on the development of a healthcare platform. An action-design approach. Contiuous research done by students. Also the living lab coordinator
	Active and assisted living (AAL)	ICT solutions for ageing well
	ZonMw	Healthcare innovation research institution
Government	Rotterdam	Potential client
	Alkmaar	Client. Problem owner
	Leiden	Client. Problem owner
Organizations	VodafoneZiggo	System integrator

	IBM	Watson technology. Hosting and infrastructure.
	ICTU	Architectual development for the government. This would be their first public-private cooperation to build a reference architecture for.
	MedRecord	Large database with medical information that they are allowed to share.
	West IT	SME tech company that build the software of the platform. See the living lab as an opportunity to come into contact with other companies.
	UL	Want to account for the entire transaction part.
	Talenter	Link to the municipalities in the Netherlands. See zo-dichtbij as a complement to their expertise.
	eHealth company	Owner platform building blocks
	Burst	
Civil society	Elderly & informal caregivers	End-users.
Funding partners	BAVO stichting	
	Stichting Gezondheidszorg Spaarneland (SGS)	
Strategic partner	KPMG	Strategic partner on platform creation and funding.

Appendix 11 – Close-by living lab approach

Openness Close-by

Aspect	Explanation	Score
Amount of stakeholders	21	5
Diversity of stakeholders	Diversity is high; university, municipalities, organization with large diversity, users, funding partners, strategic partner, care institutions, innovation institutions	5
Knowledge present in living lab	Since the core group of partners is so large there is a lot of knowledge and resources present in the living lab. No need to seek external partners for complementary resources.	5
Stakeholders involved throughout process	Stakeholders are involved from idea generation phase until market launch. There are involved in serveral workshops on for ie. Design sessions and revenue models.	5

Continuity Close-by

Aspect	Explanation	Score
Trust	Until now trust within the living lab is very high. They think this might change in the market launch phase. Multinationals are less trusted by the living lab partners.	4
Network stability	Only one partner has left the living lab due to conflicting interests (IBM-Oracle, Oracle left). Other than that, the network is very stable and most partners have been committed for almost 5 years	5
Interaction between stakeholders	Every 2 months the entire consortium comes together. Most interaction occurs in small groups arranged by the Living lab coordinator e.g. about the architecture. or bilaterally with the coordinator.	4

Empowerment of user Close-by

| Aspect	Explanation	Score
Innovation based on needs of the user	Innovation is very need based, but also based on the needs of other stakeholders, such as the organizations.	4
User involved throughout the entire process	Throughout the entire process; planning, concept design, prototype. Market launch is phase is more for the other parties involved.	5
Weight of the user's voice	Throughout the entire development phase, the user's voice was most important. They are heavily involved, also in decision making processes and some of them are even involved in consortium meetings. However, the other partners involved are of influence as well.	4

Realism Close-by

Aspect	Explanation	Score
Context	Innovation is tested in a room at the TU-Delft with different groups each time. After that it is tested in the user's home environment and in the real-life context of multiple stakeholders.	5
Different views taken into account	Elderly, informal caregivers, professional caregivers (also from the UK), intermediaries and business stakeholder's view taken into account	5
Users representative for target population	Users are from different places each time; a neighbourhood, acquaintances of the living lab coordinator, Pieter van Forees, Gouden dagen or other care institutions. Also elderly from different ages. Most of them are 55-75, but also more older.	5

Network governance Close-by

Aspect	Explanation	Score
Governing actor	Provider-driven	-
Roles & Responsibilities	Survey to determine roles and responsibilities. Stakeholders know what their task is.	5
Managing expectations	Coordinator wants stakeholders to keep their goals sharp and make sure that they receive their expected benefits	5
Goal consensus	All stakeholders have their own goal within the living lab, but agree on the overarching goal: creating a platform to enable elderly to live in their homes longer.	4
Decision-making processes	Big strategic elements are discussed during workshops with all stakeholders. Smaller elements are discussed and decided on in smaller groups	4

Appendix 12 – Workshop Close-by
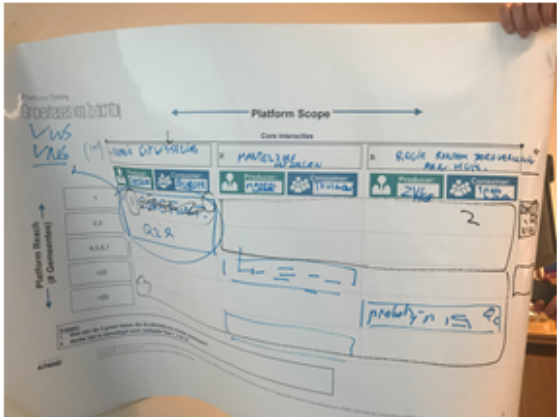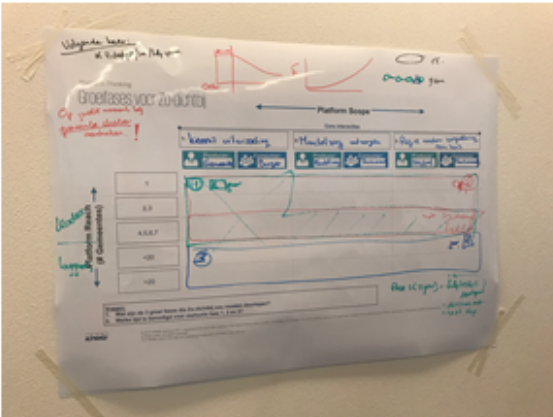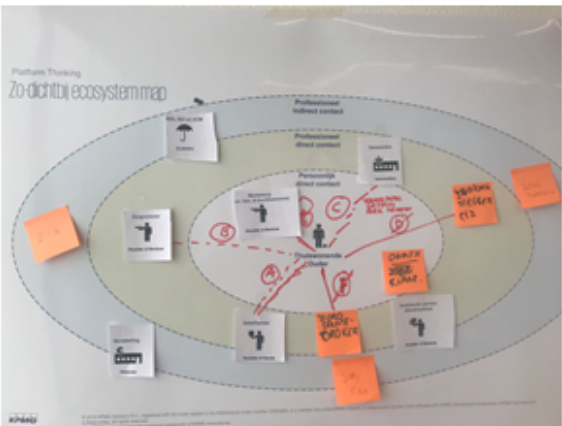
Appendix 13 - Innovate Dementia Innovations

Figure 7-5 The Homing Compass.

Figure 4-5 The PhysiCAL calendar

Figure 5-2 The Vitaallicht©, an intelligent lighting system.

Figure 6-1 The GoLivePhone® interface menu tree.

Appendix 14 - Living lab partners innovate dementia

Stakeholder group	Partner	Role in the project
Academia	TU Eindhoven	Research and participation in the intelligent lightning institute
Government	Municipality of Eindhoven	**Subsidization**
Organizations	Brainport	Innovation facilitator and international coordination
Civil society	GGzE	End-user

Appendix 15 - Innovate Dementia living lab approach

Openness - Innovate Dementia

Aspect	Explanation	Score
Amount of stakeholders	The living lab has a limited size of stakeholders. The core group exists of only 4 stakeholders.	2
Diversity of stakeholders	Stakeholders involved are users, an university, a (mental) care institution, the municipality of Eindhoven and an intermediary between the network of business stakeholders and the living lab	3
Knowledge present in living lab	The living lab seeks for external parties throughout the process to complement the knowledge in the living lab	2
Stakeholders involved throughout the process	Business stakeholders only involved in the market launch phase.	2

Continuity – Innovate Dementia

Aspect	Explanation	Score
Trust	Trust in consortium is very high. Trust with business stakeholders is very low, because they feel not involved.	3
Network stability	Stability of the consortium is very high. Relationships with business stakeholders were short-term.	3
Interaction between stakeholders	Interaction among consortium members is frequent, while there is no real interaction between the consortium members and business stakeholders. Sometimes bilateral.	3

Empowerment – Innovate Dementia

Aspect	Explanation	Score
Innovation based on needs of the user	Some innovations from scratch which are highly based on the needs of the user. The living lab also introduces already existing products, for development.	3
User involved throughout the entire process	Homing compass and physical innovations user is involved from idea generation till product development. Other innovations user is only involved in the product development phase.	4
Weight of the user's voice	Users are able to provide feedback, but are not involved in decision making processes. The weight of their voice in new product development is high, but not so much in product development of already existing products.	3-4

Realism – Innovate Dementia

Aspect	Explanation	Score
Context	Context is as realistic as possible, within their home environment	5
Different views taken into account	Not only people with dementia, but also their informal caregivers and various kinds of care professionals are involved in the process	3
Users representative for target population	Only people with early-mild stage dementia are involved, because they still have a sense of self. This only represents a sub-group of the target population. Moreover, the nr of participants was too small.	2

Network governance - Innovate Dementia

Aspect	Explanation	Score
Governing actor	Provider-driven	-
Roles & Responsibilities	It was a long search for the living labs to define the division of roles within the living lab. Eventually, there was some sort of division of tasks	3
Managing expectations	Expectations of business stakeholders not well managed. They expected their product to be tested and receive useful feedback while the consortium mainly thought of their own research agenda.	2
Goal consensus	Consortium wanted to expand knowledge and theory on innovating with people with dementia, while business stakeholders want to develop their product.	2
Decision-making processes	Among consortium members very high involvement and very democratic decision-making processes. Business stakeholders not involved, due to impatience.	3

Appendix 16 - Innovations Izi (examples)

Appendix 17 - Living lab partners Izi gezond lang thuis

Stakeholder group	Partner	Role in the project
Academia	LUMC	Research on quality of life and cost efficiency
	Haagse Hogeschool	Research on design of applications
	Universiteit Tilburg	Research on matching technology with elderly
Government	Municipality of The Hague	Coordinator of the living lab
Organizations	Haagwonen	Housing corporation that offer the Izi flat
	Ixtra	Consultants that engage into conversations with the elderly to find their needs
Civil society	Citizens of the Hague	Test the technology in their homes. All citizens come from the same flat.

Appendix 18 – Izi gezond lang thuis living lab approach

Openness – Izi living lab

Aspect	Explanation	Score
Amount of stakeholders	8	3
Diversity of stakeholders	Universities, Municipality of Den Haag, Users, Housing corporation, care organizations. Suppliers are not part of the partner group of the living lab, but are individually approached. They are suppliers and not really co-creators.	3-4
Knowledge present in living lab	There is not sufficient knowledge present in the living lab to attain to most effective outcomes.	3
Stakeholders involved throughout the process	Municipality started on their own as a project and later on invited other stakeholders. Business stakeholders are not really involved in the project but are seen as suppliers of goods.	2

Continuity – Izi living lab

Aspect	Explanation	Score
Trust	There is no trust in the living lab. Everyone is under contract, which is a substitute for trust.	2
Network stability	Business stakeholders are only invited for 1 year in the living lab. Everyone is under contract and consortium is not strong.	2
Interaction between stakeholders	There was a helix meeting, but it not anymore. Meetings are more bilateral. Mainly with government, but it could be arranged if 2 parties want to deliberate with each other. Stakeholders are not really cooperating or co-creating.	2

Empowerment of user – Izi living lab

Aspect	Explanation	Score
Innovation based on needs of the user	Research is done on the need of the user, which subsequently is linked to already existing technologies.	2
User involved throughout the entire process	User is only involved in the product development or market launch phase.	3
Weight of the user's voice	Users in the living lab are taken really seriously and they have a lot to say, but when it comes to product design or development, users can give little input.	2

Realism – Izi living lab

Aspect	Explanation	Score
Context	Products are tested in the user's home environment.	5
Different views taken into account	Only the view of the elderly is taken into account in the Leefwereld onderzoek and when it comes to most innovations within the living lab, only the business stakeholder's view is taken into account. Only products are tested by the elderly and their informal caregiver	2
Users representative for target population	Users involved are outspoken elderly who are actually quite well. Vulnerable elderly or foreign elderly are not involved. And tests are with a rather small amount of users per product.	2

Network governance – Izi Living lab

Aspect	Explanation	Score
Governing actor	Enabler-driven	-
Roles & Responsibilities	There is uncertainty about the division of roles in the process. Who is responsible for what.	2
Managing expectations	Business stakeholders expected the municipality to coordinate everything more instead of just facilitating and research stakeholder expected the living lab to be more about co-creation instead of every stakeholder performing its own task.	2
Goal consensus	All stakeholders have their own goal within the living lab. The partners are not really cooperating to attain a common goal	2
Decision-making processes	On higher level there are almost no collective decision-making processes, on lower level decision-making processes are more democratic.	2