Department of Industrial Engineering and Management

Living Labs as Open Innovation Networks

Networks, Roles and Innovation Outcomes

Seppo Leminen

Aalto University

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Living Labs as Open Innovation Networks

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Seppo Leminen

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Abstract

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Abstract

The importance and benefits of open innovation networks are widely accepted. Enterprises and other organisations are increasingly utilizing a variety of open innovation networks in different contexts. This study defines a living lab as a concept including real-life environments, a multitude of different stakeholders, and the importance of users as a part of innovation activities. Living labs are interesting because they represent a new way of organizing innovation activities by facing parallel socio-economic challenges and technological opportunities. This study aims to understand networks, user and stakeholder roles, and outcomes generated in living labs. The study has the following research questions:

- What is a living lab, from a network perspective?
- What roles do users and stakeholders have in living lab networks?
- How do network structures affect outcomes in living labs?

The research paradigm of this dissertation is grounded in constructivism. This study applies abductive reasoning as the research approach, where the study is grounded in literature on living labs and consists of empirical data on 26 living labs in Finland, Sweden, Spain and South Africa. The study offers many theoretical contributions and defined concepts for the living labs literature. Among the theoretical contributions, this study identifies seven new stakeholder roles (coordinator, builder, messenger, facilitator, orchestrator, integrator and informant), and four role patterns (role ambidexterity, reciprocity, temporality and multiplicity) in living labs. Next, this study highlights that collaboration and outcomes in living labs are achieved in the absence of strict objectives. This contribution is unique: many other studies on innovation propose that innovation activities should be managed and controlled. Further, this study identifies centralised, decentralised and distributed networks structures in living lab networks and uses them to analyse innovation activities in living labs. This study also reveals that network structures support the various types of innovations in living lab networks.

This study offers tools and frameworks for managers and researchers to understand, identify and categorise open innovation networks and pursue innovation development in open innovation networks, particularly in living lab networks. For the future, this dissertation suggests nineteen propositions and a range of other research opportunities for open innovation networks and particularly living labs but also for contingency theory and the resource-based view.

Keywords Living lab, network, role, innovation, innovation outcome, open innovation, resource-based view, contingency theory, living laboratory, living labbing, living lab network, open innovation network, network structure, inhalation-dominated innovation, exhalation-dominated innovation, research stream, proposition

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Tiivistelmä

Avointen innovaatioverkkojen merkitys ja hyödyt ovat laajalti hyväksyttyjä. Yritykset ja muut organisaatiot hyödyntävät yhä enemmän avoimia innovaatioverkkoja eri konteksteissa. Väitöskirja määrittelee living labin koostuvan tosielämän ympäristöistä, lukuisista eri toimijoista ja korostavan käyttäjien merkitystä innovaatiotoiminnassa. Living labit ovat mielenkiintoisia, sillä ne edustavat uutta tapaa organisoida innovaatiotoimintaa, joissa kohdataan rinnakkaisia sosioekonomisia haasteita ja teknologisia mahdollisuuksia. Tutkimuksen tavoitteena on ymmärtää living lab -verkkoja, toimijoiden ja käyttäjien rooleja sekä living labeissä syntyviä innovaatioita. Väitöskirjan tutkimuskysymykset ovat:

- Mikä living lab on verkkojen näkökulmasta?
- Millaisia rooleja käyttäjillä ja toimijoilla on living lab -verkoissa?
- Miten living lab -verkkojen rakenteet vaikuttavat niiden tuloksiin?

Väitöskirja perustuu konstruktivismiin. Työssä hyödynnetään abduktiivista tutkimusotetta, joka rakentuu living labbejä käsittelevään kirjallisuuteen sekä Suomesta, Ruotsista, Espanjasta ja Etelä-Afrikasta kerätyn 26 living labiä sisältävän empiirisen datan vuoropuheluun. Tutkimus tarjoaa monia tuloksia sekä konsepteja living lab -kirjallisuuteen. Esimerkiksi väitöskirja tunnistaa seitsemän uutta toimijan roolia (koordinaatttori, rakentaja, viestinviejä, fasilitaattori, orkestraattori, integraattori ja informaattori) sekä neljä roolin muotoa (roolin samanaikaisuus, molemmin-puolisuus, väliaikaisuus ja moninaisuus). Tämä tutkimus korostaa, että living labsissä saavutetaan tuloksia ilman tiukkoja ennalta määriteltyjä tavoitteita. Tämä tulos on ainutlaatuinen koska aiemmat tutkimukset ehdottavat, että innovaatiotoiminta tulisi olla ennalta määriteltyä ja hallittavaa. Lisäksi väitöskirja tunnistaa keskitetyn, hajautetun ja moninkertaisen verkon rakenteet living lab -verkoissa ja käyttää niitä innovaatiotoiminnan analysointiin living labseissa.

Väitöskirjassa kuvataan verkkorakenteiden tukevan erityyppisten innovaatioiden syntymistä living lab -verkoissa. Tutkimus tarjoaa työkaluja ja viitekehyksiä johtajille ja tutkijoille avoimen innovaation verkkojen, erityisesti living lab -verkkojen ymmärtämiseen, tunnistamiseen ja luokittelemiseen sekä niiden kehittämiseen. Tämä väitöskirja esittää yhdeksäntoista propositiota ja monia muita tutkimusmahdollisuuksia avoimiin innovaatioverkkoihin ja erityisesti living labeihin mutta myös kontingenssiteoriaan ja resurssipohjaiseen näkemykseen.

Avainsanat Living lab, verkko, rooli, innovaatio, avoin innovaatio, resurssipohjainen näkemys, kontingenssiteoria, living laboratory, living labbing, living lab verkko, avoin innovaatioverkko, verkon rakenne, inhalation-dominated innovation, exhalation-dominated innovation, tutkimusvirtaus, propositio

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Espoo, August 3rd 2015

Seppo Leminen

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1) Leminen, S. & Westerlund, M. (2012) "Towards Innovation in Living Labs Networks", *International Journal of Product Development,* Vol. 17, No. 1/2, pp. 43-59.

2) Leminen, S., Westerlund, M. & Nyström, A.-G. (2014) "On Becoming Creative Consumers – User Roles in Living Labs Networks", *International Journal of Technology Marketing,* Vol. 9, No. 1, pp. 33-52.

3) Nyström, A.-G., Leminen, S., Westerlund, M. & Kortelainen, M. (2014) "Actor Roles and Role Patterns Influencing Innovation in Living Labs", *Industrial Marketing Management*, Vol. 43, No. 3, pp. 483–495.

4) Leminen, S. (2013) "Coordination and Participation in Living Lab Networks", *Technology Innovation Management Review,* Vol. 3, No. 11, pp. 5-14.

5) Leminen, S., Westerlund, M., Nyström, A.-G. & Kortelainen, M. (2015a in press) "The Effect of Network Structure on Radical Innovation in Living Labs", *Journal of Business Industrial Marketing*.

CONTRIBUTIONS OF ARTICLES

Contributions of each article have specified as following:

1) Leminen, S. & Westerlund, M. (2012) "Towards Innovation in Living

Labs Networks", *International Journal of Product Development,* Vol. 17, Nos. 1/2, pp. 43-59.

Contributions: Leminen´s idea was revised together with Westerlund. The theoretical reasoning and writing were a joint effort by all the authors.

2) Leminen, S., Westerlund, M. & Nyström, A.-G. (2014) "On Becoming Creative Consumers – User Roles in Living Labs Networks", *International Journal of Technology Marketing*, Vol. 9, No. 1, pp. 33-52.

Contributions: Leminen's idea was revised together with Westerlund and Nyström. The theoretical reasoning and writing were a joint effort by all the authors.

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4) Leminen, S. (2013) "Coordination and Participation in Living Lab Networks", *Technology Innovation Management Review,* Vol. 3, No. 11, pp. 5-14.

Contributions: Sole author

5) Article 5, Leminen, S., Westerlund, M., Nyström, A.-G. & Kortelainen, M. (2015a in press) "The Effect of Network Structure on Radical Innovation in Living Labs", *Journal of Business Industrial Marketing*.

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Usage of external services in the dissertation

The candidate used following external services in the dissertation's PART I and Part II.

External service, language proofreading in Part I

The language of the dissertation's PART I has been checked by Chris McPhee. I have personally examined and accepted/rejected the results of the language check one by one. This has not affected the scientific content of my dissertation.

External services in Part II

Transcribing interviews

The recorded interviews were transcribed by the literacy service, Annan Pura Ltd, and the students participating in research activities in the research projects. I followed and accepted all the transcribed interviews. Hence, I underline that the transcribing interviews have not affected the scientific content of my dissertation.

Language proof checking

Mrs. Pia Nyström has checked the language of article 3, after the final version of the article was accepted for *Industrial Marketing and Management*. I have personally examined and accepted/rejected the results of the 'language check' one by one as a co-author of the article. The checking of the language of the article has not affected the scientific content of my dissertation.

1. Introduction

This chapter highlights the importance of living labs as an emerging research area. It briefly couples living labs to ongoing parallel changes in the socio-economic environment and technological opportunities in embedded contexts. Parallel with such changes and opportunities, there is an ongoing paradigm change that is opening up innovation. Next, the chapter guides the reader to the objective and the research questions of this study. It concludes with delimitations and by briefly outlining the structure of this dissertation.

1.1 Background: why living labs are interesting

Emergence of living labs

Hardly any research is conducted in an isolated bubble; instead, research involves interactions with the surrounding society, where a variety of parallel socio-economic changes take place. It is suggested that living labs are coupled to such societal changes. In accordance with Westerlund and Leminen (2011), this study defines living labs as "*physical regions[1] or virtual realities[2], or interaction spaces[3], in which stakeholders form public–*

[1] In accordance with the Oxford Dictionary, this study defines a (physical) region as an area, especially part of a country or the world, having definable characteristics but not always fixed boundaries.
[2] Also in accordance with the Oxford Dictionary, this study defines virtual reality as the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.
[3] This study defines an interaction space as a real-life environment, a space or a region, where stakeholders participate in a broad variety of innovation activities.

private–people partnerships (4Ps) of companies, public agencies, universities, users, and other stakeholders, all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts, 20." In European societies, multiple challenges are being faced, including decreasing competition and an ageing population. These challenges lead us to search for new ways to organise innovation initiatives and find additional sources and resources for innovations (Eriksson et al., 2005). The European Commission partially responded to these challenges and opportunities by following the ideas of visionary thinkers and industrial leaders to boost European-level research into developing and applying concepts of living labs (European Commission, 2005, 2009: Kipp & Schellhammer, 2008; Schumacher & Niitamo, 2008; Niitamo & Leminen, 2011). The living lab movement was organised through the Helsinki Manifesto, which was led by the Finnish prime minister in 2006, during the Finnish EU Presidency (Niitamo & Leminen, 2011). Accordingly, the number of living labs has increased. The first wave of living labs in the European Network of Living Labs (ENoLL) was organised in 2007, and currently there are more than 350 living labs recognised in Europe and globally into ENoLL in 2013 (www.enoll.org). Professor William Mitchell from the Massachusetts Institute of Technology (MIT) is often acknowledged as "the grandfather of living labs". His work is known in the area of urban design for networked "smart" cities (Mitchell, 1999), among many other contributions. Further, with his research team, he introduced and applied a living lab approach in a leading European ICT company (Niitamo & Leminen, 2011). This groundbreaking research in MIT ultimately led to the establishment of both nationwide living lab networks and ENoLL (Niitamo & Leminen, 2011).

New technologies open opportunities

New technologies, such as ubiquitous computing, ambient intelligence, augmented reality and other ICT technologies, open new research opportunities for understanding the contexts in which they can be embedded, such as living in smart places and smart rooms (Pentland, 1996; Coen, 1998; Hirsh, 1999), interactive workspaces (Johanson et al., 2002), smart artefacts (Streitz, 2005) and experimenting in ExperienceLab environments, which consist of home, shop and care environments (de

Ryuter et al., 2007). Such studies on embedded contexts exemplify utilisations of new technologies in living contexts in late 1990's and early 2000's. Whereas literature (cf. Markopoulos & Rauterberg, 2000) documents research conducted on smart rooms and homes at Georgia Tech Labs (Abowd, 1999; Abowd et al., 2000), the Dr Tong Louie Living Laboratory[4], the adaptive House at Boulder, Colorado (Mozer, 1999), demonstration houses at Brussels[5] and the interactive environment at MIT[6] and demonstration house by Microsoft (Brumitt et al., 2000).

Open and closed innovation

In the closed innovation paradigm, only limited numbers of different stakeholders participate in innovation (Kanter, 2006). Closed innovation assumes that a company or an organisation limits the use of knowledge and resources from outside the company or its trusted network but relies primarily on its own knowledge and resources when developing or commercializing its products and services (Gassmann, 2006). Thus, only limited numbers of stakeholders have access to knowledge (Bendavid & Cassivi, 2012). Mulvenna et al. (2010) characterise closed innovation as a linear process that is driven and managed by industrial parties. In contrast to closed innovation, perhaps one of the most noticeable ongoing paradigm change is opening up innovation (Chesbrough, 2003). Chesbrough coined 'open innovation', which refers to a strategic choice to integrate external and internal ideas from the market. Open innovation relies on the principle that needed knowledge and resources may be acquired from outside of a company instead of holding and developing all needed knowledge inside the company (Calanstone & Stanko, 2007). The benefits of the open innovation model are proposed to include improved user value (Almirall & Casadesus-Masanell, 2010), higher innovation performance (Chiaroni et al., 2010), and reduced innovation costs (Von Hippel, 2007). However, the literature on open innovation also does provide some criticism towards the concept. For example, rather than being a coherent theory, open innovation includes

[4] Dr Tong Louie Living Laboratory. (Accessed December 2nd, 2013). Retrieved from [http://www.sfu.ca/livinglab/about_us.htm]
[5] Tomorrow lab. (Accessed December 2nd, 2013). Retrieved from [http://livingtomorrow.com/en/tomorrowlab]
[6] Interactive environment at MIT. (Accessed December 2nd, 2013). Retrieved from [http://pages.cs.wisc.edu/~jgast/cs540/demos.html]

many approaches to managing and opening innovation (Lichtenthaler, 2011). The term 'open innovation' is vague and nonprecise and requires clarification (Remneland Wikhamn & Wikhamn, 2013) and also fails to propose concrete guidelines for benefitting from innovation activities (Schuurman et al., 2015). Vanhaverbeke and Cloodt (2014) underline that open innovation research fails to couple the concept to underlying theories of the firm.

Open innovation grounds on a principle that users and customers are the focus of innovation activities rather than passive receivers of innovation. Diverse user-centric and user-driven activities have caught the attention of many companies and organisations seeking to improve existing products and discover novel solutions (Eriksson et al. 2005; Johnson, 2013). These activities are increasingly improvised and often take the form of impromptu responses to needs raised from the real world (Mulder, 2012). Open innovation remains an active research area. For example, Dahlander and Gann (2010) conducted an extensive scholarly literature review about open innovation. The authors' work typifies recent academic literature and illustrates different types of innovation as pecuniary, non-pecuniary, inbound, and outbound innovations[7]. Also, Huizingh (2011) calls for more research to further understand the concept of open innovation. Given these four types of innovation, the open innovation approach is proposed to increasingly catalyse growth and competiveness on regional, national and international levels (Mulvenna et al., 2010). Particularly, open innovation is increasingly important. Hence, innovation activities are increasingly transformed towards open innovation networks[8] in many companies and organisations, where traditional industries are attempting to collect advantage of the user-driven approach (Paulson et al., 2004; Bonaccorsi et al., 2006).

To sum up, living labs are suggested to be important and they are coupled

[7] Pecuniary innovation refers to a direct benefit to a company, and non-pecuniary innovation refers to an indirect benefit. Inbound innovation refers to the internal use of external knowledge, whereas outbound innovation refers to the external exploitation of internal knowledge (Huizingh, 2011).

[8] In accordance with Jarvenpaa and Wernick (2012), the present study refers to open innovation networks, which comprise different stakeholders, suppliers, customers, rival companies, research units of universities, and other institutions and brings their interests to collaboration and innovation.

with organizing innovation activities that provide a new means of facing parallel socio-economic challenges and offer opportunities for studying technologies in embedded contexts. In parallel to such challenges and opportunities, there is an ongoing paradigm change that is opening up innovation.

1.2 Research objectives and questions

It is frequently stated that understanding users and customers[9], and data gathered from them, is important for companies and organisations. This study uses the terms 'consumer' and 'user' synonymously. Previously companies learnt from users and customers by using traditional marketing surveys. Today, learning is shifting towards congregating customer data by integrating users in the innovation process as co-producers. Edvardsson et al. (2010) find that integrating users in the innovation process has been the key success factor in many industries. Many studies suggest that an increasing number of practitioners and managers are looking for ways to convert traditional innovation models to exploit the benefits of the open innovation paradigm, and there is increased interest in living labs at the business, governmental and European levels (Satellite News, 2006; European Commission, 2009; Westerlund & Leminen, 2011; Leminen et al., 2012a; Niitamo et al., 2012; Ståhlbröst, 2013). Huizinzingh (2011) calls for more research into understanding the context dependence of open innovation. Living labs are suggested to be a promising and emerging area, where numerous studies suggest a broad variety of benefits and opportunities, such as improving and creating business opportunities, but also providing benefits in variety of contexts and real-life environments (Appendix 1). Studies increasingly address a need to clarify living labs and their models and to provide more systematic analyses of the applicability of living labs to innovation activities (cf. Feurstein et al., 2008; Almirall & Wareham, 2009; Budweg et al., 2011). The field of living labs is still at an early stage, but it is increasingly developing towards a more mature and accepted form of open innovation. Therefore, there is an increasing impetus

[9] Leminen et al. (2014a, p. 36) characterize the distinction between a consumer and a user as "*anyone who consumes goods or services produced by companies in the economy is called a consumer, whereas people or organisations using the goods and services of specific companies are termed as users of those companies' products and services*".

for studying living labs as a mechanism for innovation.

Conventional innovation networks ground on interpreting user needs and collecting their insights, while living labs include openness and user involvement as focal points of innovation development in real-life environments (Kusiak, 2007; Almirall & Wareham, 2008b; Almirall et al., 2012). Living labs have been proposed to combine both self-organised and self-managed innovation management processes, and thus understanding of the organisation and management of living labs is needed. The majority of innovation studies apply the conventional, closed innovation paradigm, in which innovation is led by a producer, rather than applying the emerging open and user innovation philosophy (Leminen et al., 2015b). Open and user innovation studies document the roles a user may play, including the roles of lead user (Von Hippel, 1986; Von Hippel & Katz, 2002; von Hippel, 2007) and creative consumer (Berthon et al., 2007). Roles are increasingly discussed in the innovation literature, which suggests that roles are important to innovation (cf. Allen, 1970; Tushman & Katz, 1980; Howell & Higgins, 1990a, 1990b; Gemünden, 1985; Gemünden & Walter, 1988; Gemünden et al., 2007), but research is scant on roles in innovation networks and the roles linked to innovation processes, where further descriptions of stakeholder roles are needed (Lüthje et al., 2005; Morrison et al., 2000; Heikkinen et al., 2007). Studies on living labs address main stakeholders including academia (university and research centres), industry, citizens, users, and public and private organisations (Ballon et al., 2005; Westerlund & Leminen, 2011). Such studies demonstrate that there are many diverse stakeholders and activities coupled to them in living labs (cf. Cosgrave et al., 2013). In particular, studies commonly agree on the important and equivalent role of the user in innovation activities with other stakeholders (Almirall & Wareham, 2008; Følstad, 2008b; Schumacher & Niitamo, 2008; Schuurman et al., 2011). There are studies available on user typologies in living labs (cf. Schuurman et al., 2010a; Schuurman et al., 2010b) but studies on different user and stakeholder roles are scarce (cf. Corelabs, 2007; Kipp & Schellhammer, 2008). Such studies are ambiguous in explaining and defining user and stakeholder roles in living labs, where a user has an equivalent role to other stakeholders in innovation networks. Therefore, further research is particularly needed to understand user and stakeholder roles and the interplay between stakeholders in open

innovation networks. Hence, roles explain how innovation activities are organised in innovation networks and how such roles are linked to innovation outcomes in living labs (Heikkinen et al., 2007; Leminen et al., 2015b).

Innovation activities are increasingly taking place in networks rather than in a single organisation or with an individual (Powell et al., 1996). Studies articulate a variety of different actors representing many organisations in living labs (cf. Eriksson et al., 2005; Niitamo et al., 2006). The literature on living labs has scant illustrations and descriptions of living lab networks. In fact, Dekkers (2011) and Guzmán et al. (2013) call for more research into understanding innovation in living lab networks. Thus, the literature on living labs provide little evidence of the network structures of living labs and how these network structures, and roles, are coupled to innovation activities.

Living labs have been demonstrated to apply diverse aims or strategies (Almirall & Wareham, 2011), cover multiple contexts (Budweg et al., 2011) and lead to a variety of outcomes (Mulder et al., 2008; Svensson & Ihlström Eriksson 2009; Almirall & Wareham, 2011). Thus, living labs and their activities lead to diverse outcomes including products, services or systems and types of innovations including incremental and radical innovations. However, conceptualisations of innovation outcomes are particularly scarce (cf. Kusiak, 2007; Mulder et al., 2008; Almirall & Wareham, 2011). Consequently, extant literature on living labs is scant on networks, user and stakeholder roles, and innovation outcomes. Therefore, this study aims to understand living labs from the perspectives of networks, user and stakeholder roles, and outcomes. To sum up, this study formulates the following research questions to explore the objective of the study:

- What is a living lab, from a network perspective?
- What roles do users and stakeholders have in living lab networks?
- How do network structures affect outcomes in living labs?

1.3 Scope of the study

This section presents the scope of the study and several important delimitations to the research approach pursued. The first delimitation is that the study will focus on innovation development cases taking place in

living labs rather than the living labs themselves. The first delimitation is set because a living lab typically comprises many innovation development cases, and studying all living lab cases in a given living lab would be too broad and difficult to handle.

The second delimitation is that the study will take a cross-sectional approach by focusing on innovation activities taking place at a specific time period rather than forming a continuous chain of many cases. Although completed cases may affect the consequent initiatives, the second delimitation is set because this study will focus on recent cases in living labs; a focus on past cases could influence the interpretations of informants.

The third delimitation underlines that this study does not focus on living lab strategies or the development of living lab activities. Rather, it attempts to understand living labs from the perspectives of networks, roles, and innovation outcomes. Thus, living lab cases and their networks, roles, and innovation outcomes should be studied first before understanding living lab strategies and the development of living lab activities.

1.4 Structure of the study

This thesis has two parts. Part I gives an overview of the dissertation, and Part II includes the five research articles.

Figure 1 shows the relationship of the articles to the dissertation. The dissertation consists of five chapters. In Figure 1, the bold circled numbers describe chapters and the arrows between circled numbers illustrate the progress of the study. For clarity, the feedback and iterations between results, development and foundation sections and between different parts of the study are not illustrated. The foundation of the study covers research traditions but also the experience of the researcher in living labs. The study includes two notable research traditions: contingency theory and the resource-based view. The researcher has gained several years of work experience in living labs by actively participating in several research projects and activities in living labs as a scientific leader and a researcher. Further, the researcher is actively participating in an informal living lab research community that includes researchers, managers and practitioners from diverse living labs.

Chapter 1 introduces the research topic by justifying the importance of the research area, the research objective and the research questions of the study. Chapter 2 positions the dissertation with respect to research traditions in organisational studies. The chapter explains the various meanings and interpretations of living labs and characterises their constructs by examining three streams of living lab studies. The chapter gives a brief overview of the foundation for understanding living labs. Chapter 3 continues by explaining living labs from the perspectives of the networks, the user and stakeholder roles, and the outcomes in living labs. Chapter 4 synthesises the theoretical background on living labs and provides a framework, an innovation triangle of living labs, that summarises the three perspectives on this study. Chapter 5 shows the research design and research approaches of the study. The chapter also describes the research methodology, data collection and analysis. Chapter 6 gives an overview of the articles and their results. Chapter 7 shows the theoretical contributions of the study and transforms the contributions to propositions on living labs as well as on contingency theory and the resource-based view. Next, the chapter provides managerial implications. Last, the chapter discusses the relevance of the research and suggests future research topics.

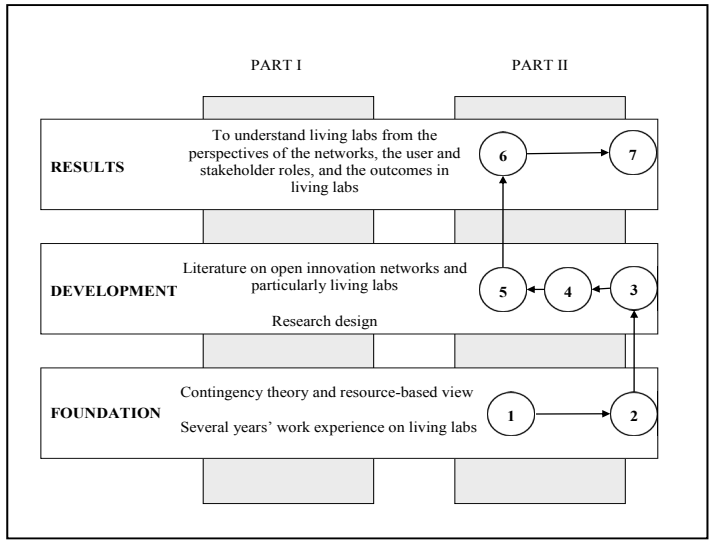

Figure 1. The structure of the thesis and its chapters

2. Towards an understanding of living labs

Chapter 2 first positions this study in relation to the two notable research traditions of organisational studies: contingency theory and the resource-based view. Next, it distinguishes living labs from other forms of open innovations such as crowdsourcing, the lead user concept and open source. Third, the chapter reviews the literature on living labs by exploring versatile meanings and interpretations of living labs, living laboratories and living labbing. Further, the chapter reveals three research streams of living labs including 'a living lab as a context', 'a living lab as a method', and 'a living lab as a conceptualisation'. Last, the chapter provides conclusions about the three versatile meanings and interpretations, and the three research streams of living labs.

2.1 Innovation research traditions

Innovation studies have grounded on different theories, views and approaches. In contrast to 'siloed' theories such as marketing theory (cf. Sheth et al., 1988), studies on innovations illuminate multiple research traditions rather than categorizing them as 'schools of innovations' (cf. Slappendel, 1996; Danziger, 2004). A variety of notable research traditions exist in organisational studies, such as contingency theory, the resource-based view, the dynamic capability approach, the transaction cost approach, and the knowledge-based view, among many others. Research traditions on organisational studies develop in interactions with other research traditions as well as other disciplines and theories rather than blossom in isolated silos (cf. Conner, 1991; Grant, 1996a; Madhok & Tallman, 1998; Barney et al., 2001; Richard et al., 2003; Vogel, 2012).

Various disciplines apply living labs and studies on living labs cross disciplines (cf. Bajgier et al., 1991; Kviselius et al., 2009). Few studies on living labs directly address or even raise questions on their theoretical underpinning(s) (Dekkers, 2011; Schuurman, 2015). Among them, Dekkers (2011) attempts to distinguish innovations in living lab networks based on different perspectives such as strategic networks, technology valorisation, contractual relationships, the resource-based view, dynamics of social relationships, knowledge management and the science of complexity. He notes that other perspectives may apply as well and proposes that those perspectives provide different and even diametrical outcomes.

Newell (2001) claims that the complexity of systems and multi-faceted objects often incorporate multiple views, where a single approach includes individual facets or sub-systems rather than a broad picture of the phenomenon. In this vein, this dissertation leans on multiple organisational research traditions to understand the multiplicity of living labs. Multiple views incorporate both multiple research approaches and interdisciplinary studies (Newell, 2001). Repko (2012) differentiates multidisciplinary and interdisciplinary studies by two metaphors: a multidisciplinary study is like to "chopped fruit in a bowl" and an interdisciplinary study is like "a fruit smoothie". The interdisciplinary study attempts to enrich different approaches by new findings rather than synthetizing them, whereas this study attempts to use a multidisciplinary approach, i.e. it draws upon multiple research traditions from organisational studies to understand living labs by suggesting propositions for the living lab literature (please see Chapter 7.4). Nevertheless, the researcher is aware of the risks and challenges of using multiple approaches where disciplinary research may result in bias. Rafols et al. (2012) note that interdisciplinary studies are often perceived as being lower quality; however, they stress that their own findings do not support this perception. Repko (2007) claims that disciplines can describe similar ideas with different concepts being alternatives or opposites to other concepts. Repko (2007) suggests reconciling conflicts between theories, conflicts between the concepts and conflicts between the assumptions. In accordance with Repko (2007), the present study later translates its contributions to the chosen notable research traditions on organisational studies (please see Chapter 7.4).

Such research traditions are contingency theory and the resource-based view. *Contingency theory* is widely used and accepted in innovation studies but also in organisation theory, strategic management, organisational behaviour and marketing studies (cf. Hickson et al., 1971; Ginsberg & Venkatraman, 1985; Zeithaml et al., 1988; Torkkeli, et al., 2009). The underlying assumption of contingency theory is 'situational influence' where no single way to organise or manage exists: it depends on the settings and contexts. In the case of living labs, they differ from each other by their real-life environments but also by the applied strategies including a variety of different stakeholders (cf. Eriksson et al., 2005; Almirall & Wareham, 2011; Budweg et al., 2011). Taken together, the present study leans on contingency theory because it focuses on situational influences. Where the underlying assumption is aligned with the assumptions of living labs, which ground on real-life environments and differ by their settings and contexts.

Further, this study leans on the second notable research tradition: *the resource-based view*. Madhok and Tallman (1998) conclude that an organisation is dependent on external resources rather than having all the needed resources and capabilities. Organisations fulfil the needs of an external environment, where they develop products and services in a timely and cost-effective manner. The present study underlines that the resource-based view is relevant for understanding living labs. The underlying assumptions of living labs include multiple different stakeholders bringing and sharing multiple resources and knowledge for living labs (cf. Eriksson et al., 2005; Schaffers & Kulkki, 2007; Westerlund & Leminen, 2011). Taken together, the underlying assumption of the resource-based view aligns with the assumptions of living labs, which ground on multiple stakeholders and their resources.

Literature on innovation includes another notable approach, the *dynamic capabilities* approach, which complements the resource-based view (Bogers, 2011). The dynamic capabilities approach seeks to effectively organise the technological, organisational and managerial processes inside companies (Teece et al., 1997). Hence, the present study does not lean on dynamic capabilities even it could have provided another viable view for understanding of living labs. Hence, living labs merge and combine activities of variety stakeholders and these activities often take place and are facilitated

beyond organisational boundaries (cf. Ballon et al., 2005; Almirall & Wareham, 2008b; Ståhlbröst, 2008; Dutilleul et al. 2010).

Further, *the knowledge-based view* could have been another viable research tradition for understanding living labs, where the knowledge-based view tradition is associated with the resource-based view (cf. Peteraf, 1993; Grant, 1996a). In contrast to the resource-based view, the knowledge-based view emphasises knowledge creation and "social interaction" between tacit and explicit knowledge (Nonaka, 1994). Nonaka et al. (2008) claim that new meanings are created through interactions and knowledge creation in "ba"[10]. More specifically, new meanings are created through interactions, where stakeholders are able to share their tacit everyday life experiences. Even though knowledge creation takes place in living labs, the present study does not lean on the knowledge-based view, because it focuses on knowledge-creation processes that benefit companies rather than merging interactions and knowledge creation for the benefit of all stakeholders in networks.

Last, the transaction-cost economics approach is widely used in organisational studies. The premise of the transaction-cost economics approach is to manage transactions efficiently with minimum cost (Williamson, 1979; 1985). The present study takes another stance and underlines that even some living labs aim to efficiently manage their activities and procedures (cf. Schuurman et al, 2013). The studies on living labs increasingly claim that innovations are not managed but rather are facilitated (cf. Westerlund & Leminen, 2011). Living labs are widely associated with many stakeholders and, in particular, the importance of users (Ballon et al., 2005), which pursue a continuum of goals and targets for a variety of stakeholders (Leminen et al., 2012a). Hence, the transaction-cost economics approach unnecessarily limits the pluralistic nature of living labs; living labs do not fulfil the needs and goals of a single organisation but all the organisations participating in living lab activities (Leminen, 2011). Table 1 briefly exemplifies the research traditions on organisational studies and their relevance in living lab research.

[10] Nonaka et al. (2008) define 'ba' as a shared context in motion, in which knowledge is shared, created, and utilized.

Table 1. Relevance of research traditions to living labs

Research traditions	Key idea(s) and sources	Relevance of research traditions to living labs
Contingency theory	No single way to organise or manage exists; rather, an approach is dependent on settings and contexts (Hickson et al., 1971)	• Living labs illuminate situational influence • A broad variety of constellations, real-life environments and stakeholders exist (Eriksson et al., 2005; Almirall Wareham, 2011; Budweg, et al. 2011)
Resource-based view	An organisation is dependent on external resources rather than having all the needed resources and capabilities. Organisations fulfil the needs of an external environment, where they develop products and services in a timely and cost-effective manner (Madhok & Tallman, 1998).	• Living labs assume a broad variety of stakeholders that bring, share and develop resources together (Eriksson et al., 2005; Schaffers & Kulkki, 2007; Westerlund & Leminen, 2011)
Dynamic capabilities	Internal and external competences are integrated, built and reconfigured to address rapidly changing environments (Teece et al. 1997, 516).	• The approach aims to organise effectively the technological, organisational and managerial processes inside companies (Teece et al., 1997) • Living labs merge and combine the activities of stakeholders, and these activities often take place and are facilitated beyond organisational boundaries (Ballon et al., 2005; Almirall & Wareham, 2008b; Ståhlbröst, 2008; Dutilleul et al. 2010)
Knowledge-based view	Knowledge is created in social interaction between tacit and explicit knowledge (Nonaka, 1994).	• New meanings are created through interactions • This view focuses on knowledge-creation processes that benefit companies rather than merging interactions and knowledge creation for the benefit of all stakeholders in networks
Transaction-cost economics	The emphasis is on managing transactions efficiently with minimum cost (Williamson, 1979; 1985).	• Living labs cover many constellations targeting both managing activities efficiently and more loosely developing innovation • Living labs are widely associated with many stakeholders and particularly the importance of users, who pursue a continuum of goals and targets for a variety of stakeholders

2.2 Differentiating living labs from other forms of open innovation

There is a range of other forms of open innovation including 'crowdsourcing'[11] (cf. Howe, 2006; Estellés-Arolas & González-Ladrón-de-Guevara, 2012), 'lead users'[12] (cf. Von Hippel, 1986; Von Hippel & Katz, 2002), 'innovation community'[13] (cf. Pisano & Verganti, 2008), 'innovation mall'[14] (Pisano & Verganti, 2008), and 'open source'[15] (cf. Feller & Fitzgerald, 2002; Bonaccorsi et al., 2006; Lakhani & von Hippel, 2003).

Almirall and Wareham (2008b) distinguish living labs in the context of open innovation. The authors clarify that a living lab may act as (i) an experimentation platform with plentiful users to embrace innovation process with them, (ii) lines of research, and (iii) an intermediary activating and creating connections between stakeholders. Living labs differ from other forms of open innovation. For example, Bergvall-Kåreborn et al. (2009b) differentiate living labs from crowdsourcing and lead users. The authors argue that a living lab approach embeds both a context and an approach to innovation, whereas lead users and crowdsourcing approaches are merely approaches to innovation. Almirall et al. (2012) in turn suggest that living lab, lead user and open source approaches ground on innovation activities in real-life environments. The present study share the views of Almirall et al. (2012) and Bergvall-Kåreborn et al. (2009b) that living labs are real-life environments often associated with a broad continuum of innovation activities. Bergvall-Kåreborn et al. (2009b) compare a living lab to open

[11] Estellés-Arolas and González-Ladrón-de-Guevara (2012, 9-10) define crowdsourcing as *"a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilize to their advantage that what the user has brought to the venture, whose form will depend on the type of activity undertaken."*

[12] Von Hippel (1986, 791) defines lead users as "*users whose present strong needs will become general in a marketplace months or years in the future*".

[13] Pisano and Verganti (2008, 81) state that an innovation community is "*where anybody can propose problems, offer solutions, and decide which solutions to use."*

[14] Pisano and Verganti (2008, 81) state that an innovation mall is *"where one company posts a problem, anyone can propose solutions, and the company chooses the solutions it likes best."*

[15] Estellés-Arolas and González-Ladrón-de-Guevara (2012, 12) define open source as "*access to the essential elements of a product to anyone for the purpose of collaborative improvement to the existing product*", in accordance with the Open Source Initiative (OSI, 2014).

innovation claiming that living labs are focused on business-to-consumers interactions, whereas open innovation focuses on business-to-business interactions. They propose that open innovation focuses on business models, whereas living labs mainly focus on elements of business models, products and services. Bergvall-Kåreborn et al. (2009b) claim that living labs consider the whole innovation process rather than merely focusing on ideas and technology. The present study partially share the view of Bergvall-Kåreborn et al. (2009b) that living labs merely focus on elements of business models, products and services. Hence, the present study underlines that living labs focus on products and services but some studies attempts to incorporate and extend living labs towards markets pilots (cf. Bliek et al., 2010, Ferrari et al., 2011) or explain the business models of living labs (cf. Schaffers et al., 2007; Katzy, 2012; Mastelic et al., 2015; Rist et al., 2015).

There have been attempts to pair the lead user concept and living labs (cf. Schuurman & De Marez, 2009), where a living lab has been seen as an "empty box" filled with different methodologies. Von Hippel (1986) claims that lead users face changes earlier than rest of the users in market(s). In contrast to the lead user concept, living labs cover lead users but also other types of users such as ordinary users (Lin et al., 2012b). Hence, the present study underlines that the lead user concept only partially covers the continuum of users rather than incorporating a broad variety of users including ordinary citizens, customers and users as proposed by Niitamo et al. (2006). Further, lead users and "everyday" users are dissimilar, thus lead users identify development needs earlier than a majority of everyday users, and lead users eagerly participate in innovation development activities (von Hippel, 1986; Urban & von Hippel, 1988; Lettl, 2007). There is a potential overlap of the lead user concept and the living lab concept but these concepts should not be considered as synonyms.

(i) Living labs are based on public–private–people partnerships (4Ps) (cf. Westerlund & Leminen, 2011), whereas other forms of open innovations are based on a more limited collaboration between a variety of stakeholders in innovation networks (cf. von Hippel, 1986; von Hippel & Katz, 2002; Chesbrough, 2003, 2006; Howe, 2006; Estellés-Arolas & González-Ladrón-de-Guevara, 2012).

(ii) Living labs assume that innovation activities occur in real-life environments. Similar to living labs, lead user and open source approaches rely on real-life environments (cf. Bergvall-Kåreborn et al., 2009b). Almirall et al. (2012) propose that crowdsourcing takes place in real-life environments but the current study emphasises that crowdsourcing is not limited to real-life environments but may take place in other contexts such as in laboratory environments when searching for ideas or solutions. Further, crowdsourcing relies on many participants, who often work independently in their innovation activities, whereas living labs gather a variety of different stakeholders for joint innovation activities. Also, in contrast to crowdsourcing, living labs often have a limited number of users. Finally, living labs involve a broad variety of users rather than focusing on lead users.

(iii) The literature on living labs emphasises the importance of users. A user role can be passive or active or a user can be an object or a subject of a study (cf. Ballon et al., 2005; Leminen, 2011; Almirall et al., 2012). Lead user, open source and crowdsourcing approaches view users as active participants or an object of a study, whereas open innovation sees a user as a subject of a study (cf. Leminen, 2011; Almirall et al., 2012).

To sum up, this study argues that a public–private partnership or a public–private–people partnership is not just desirable, it is an essential element of a living lab. Thus, living labs are grounded on innovation in real-life environments and the importance of users is emphasised as a part of activities there. Hence, living labs are less structured and bounded than other forms of open innovations, enabling more variability and freedom for innovation. Table 2 shows similarities and differences between living labs and other forms of open innovation.

Table 2. Living labs versus other forms of open innovation

Forms of open innovation	Collaboration, context and characteristics of innovation	Source
Open innovation	**Collaboration and focus** B2B (business to business)	cf. Chesbrough 2003, 2006

	Context Business relationships **User interaction and activeness** A user as a subject of a study	
Living lab	**Collaboration and focus** Public–private–people partnerships (4Ps) **Context** Real-life environments **User activeness and creativeness** Range between users as passive and active participants or a user as an object or a subject of a study	cf. Westerlund & Leminen 2011 cf. Bergvall-Kåreborn et al. 2009b cf. Ballon et al. 2005; Leminen 2011; Westerlund & Leminen, 2011; Almirall et al. 2012
Lead user concept	**Collaboration and focus** B2B, B2C (business to consumer) **Context** Real-life environments **User interaction and activeness** Users as active participants or an object of a study	cf. von Hippel 1986; von Hippel & Katz 2002; Edvardsson et al. 2012 cf. Almirall et al. 2012 cf. Almirall et al. 2012
Open source	**Collaboration** B2C **Context** Real-life environments **User interaction and activeness** Users as active and co-creative participants	Feller & Fitzgerald, 2002; Bonaccorsi et al., 2006; Lakhani & von Hippel, 2003 Almirall et al. 2012 Almirall et al. 2012
Crowdsourcing	**Collaboration and focus** B2C **Context** Real-life environments or laboratory environments **User interaction and activeness** Users as active and co-creative participants	Howe, 2006; Estellés-Arolas & González-Ladrón-de-Guevara 2012 Almirall et al. 2012 Almirall et al. 2012

2.3 Living labs: versatile meanings and interpretations

This subchapter gives a brief introduction to the meanings and interpretations of living labs. Three types of meanings are presented: 'living lab´ often includes the perspective of all stakeholder engagement in real-life environments; 'living laboratories' in many cases refer to applying an organisation's perspective; while 'living labbing' refers to the efforts of local stakeholders in innovation. However, no universally accepted definitions for

the meanings exist. In accordance with the extant studies, this study uses them interchangeably.

Living labs integrate a wide range of expertise (Abowd et al., 2000). Studies on living labs have concerned a broad range of fields or sectors including agriculture (Wolfert et al., 2010), beer making (Baida et al., 2008), dementia and health care (Galbraith et al., 2008; Panek & Zagler, 2009; Kanstrup et al., 2010; Nielsen & Nielsen, 2011; Panek et al., 2011; Pino et al., 2014; Turkama, 2014; Brankaert et al., 2015), education and learning (Li et al., 2009; Kröse et al., 2012; Femeniás & Hagbert, 2013; Luojus & Vilkki, 2013), environmental pollution (Trousse et al., 2014), nutrition (Lin et al., 2012a; Lin et al., 2013), and pharmaceutics (Liu et al., 2010), among many others. Living lab environments include cities (Oliveira et al., 2006; Farrall, 2012; Haukipuro et al., 2014), smart cities (Ballon et al., 2011; Sauer, 2012; Marasso et al. 2014; Baccarne et al., 2014), urban areas (Cunningham et al., 2012), rural areas (Schaffers et al., 2007; Schwittay, 2008; Hlungulu et al., 2010; Pade-Khene et al., 2010; Mabrouki et al., 2010; Cunningham et al., 2012), museums (Saldago, 2013), and mobile living labs (Pergler & Tarkus, 2013), among many others.

Taken together, the literature documents the efforts of researchers and scholars from a variety of disciplines and a broad range of fields and sectors applying living labs to innovation challenges. The literature on living labs documents earlier attempts to review living lab concepts (Følstad, 2008b; Dutilleul et al., 2010; Schuurman et al., 2012), methodologies (Fulgencio et al., 2012) and research streams (Westerlund & Leminen, 2014). Despite the existing attempts, the studies argue that further work is needed to understand living labs, their characteristics and conceptualisations, and to integrate them with the innovation activities of organisations.

Living lab, living laboratory and living labbing

The literature on living labs uses the terms 'living lab', 'living laboratory' and 'living labbing'. Schuurman et al. (2011) attempt to differentiate American and European visions of living labs, where the former vision refers to living labs as demo-homes, home labs and 'houses of the future', and the latter vision views living labs as platforms to study users' everyday habits.

However, no universally accepted distinctions of 'living lab', 'living laboratory', and 'living labbing' exist. Rather, these terms are used interchangeably in the literature. The term 'living lab' is evolving in parallel with the term 'living laboratory', and until now, only a few studies on living labbing exist. Fulgencio et al. (2012) claim that Knight (1749) used the term 'living laboratory' the first time. Knight (1749) described a living laboratory as elements and conditions of a body and an environment of an experiment. Fulgencio et al. (2012) find another more recent usage of living laboratory in the *Billboard* weekly magazine (1956). *Billboard* described a living laboratory as a way to study users' responses to TV commercials in their living rooms by making phone calls to the users. Later roots of living laboratories can be traced back to early 1990s in the United States. A living laboratory often includes a company or utilises an organisation's perspectives, whereas a living laboratory is often a place or an environment, to which 'guinea pigs' (Eriksson et al., 2005) are brought to be studied. To simplify this view, a living laboratory often simulates a real-life environment in a lab-like setting. Living labs often emphasise real-life living environments, where a 'guinea pig' lives and works. Probably one of the earliest descriptions of the term 'living lab' can be traced to Tarricone (1990). The author introduced a living lab as a concept house for new materials and construction methods by researchers. Living labbing in turn refers to local stakeholders' efforts in innovation activities (Mulder, 2012).

To conclude: no universally accepted definitions exist for the terms living lab, living laboratory, and living labbing. Rather, the literature on living labs offers a broad variety of definitions and attempts to cover innovation activities or arenas including a broad range of constructs. In all, around 70 different definitions were found in a systematic literature review on living labs. The key characteristics of living labs are summarised in Appendix 2. This list should not be considered to cover all possible definitions but some of most the interesting examples from a broad variety of definitions. This study underlines that the concept of a living lab documents and covers perhaps the widest range of perspectives including different stakeholders such as companies, other organisations, providers (cf. academia and technology providers), enablers (cf. development agencies and financiers) and users, customers and citizens in real-life environments. This study uses the terms living lab, living laboratory and living labbing interchangeably, if

it is not stated otherwise. Table 3 shows the results of a terminology review of different definitions concerning living labs. Based on the review, four characteristics or perspectives of living labs were identified: (i) living labs as real-life environments[16], (ii) stakeholder[17], (iii) approaches, instruments, methods, methodologies[18], and (iv) concepts, conceptualizations and tools[19].

Each of these four characteristics or perspectives is coupled with use examples of activities in living labs, which this study incorporates as an additional, fifth perspective. Appendix 3 gives an overview of activities and 'use contexts' in versatile definitions of living labs. The five different characteristics or perspectives were intertwined together. This study shares the view of Bergvall-Kåreborn and Ståhlbröst (2009) that different definitions – an environment (Ballon et al., 2005; Schaffers et al., 2007), a methodology (Eriksson et al., 2005) and a system (CoreLabs, 2007) – are not contradictory but rather are complementary perspectives on living labs. It may be argued that there are slight differences between the characteristics of 'approaches instruments, methods, methodologies' and the characteristics of 'concepts, conceptualizations and tools' in living labs.

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[16] This study defines real-life environments as lived or reality surrounding, or conditions where stakeholders operate by applying definitions of 'real-life' and 'environment' in accordance with the *Oxford Dictionary*. The *Oxford Dictionary* defines real-life as "life as it is lived in reality, involving unwelcome as well as welcome experiences, as distinct from a fictional or idealized world", and environment as "the surroundings or conditions in which a person, animal, or plant lives or operates."

[17] Stakeholders include a variety of actors, such as users, citizens, public organizations, academia, research organizations and firms, involved as a part of living lab activities.

[18] This study incorporates approaches, instruments, methods, and methodologies in accordance with the *Oxford Dictionary*, as a particular way of, or a system of methods used in living labs of study for accomplishing or approaching something. The *Oxford Dictionary* defines an approach as "a way of dealing with a situation or problem", an instrument as "a tool or implement, especially one for precision work", a method as "a particular procedure for accomplishing or approaching something, especially a systematic or established one", and methodology as "a system of methods used in a particular area of study or activity.

[19] This study includes concepts, conceptualizations and tools in accordance with the *Oxford Dictionary* and defines them as a formalized structure, model, construction, or framework to understand living labs or its activities. The study underlines the difference between an approach and concept. The former focuses on a particular 'way' of understanding living labs, whereas the latter does not focus on a method itself but further conceptualisations such as stakeholders, networks, roles, innovation outcomes on conceptualisation abstractions of living labs.
The *Oxford Dictionary* defines a concept as "an abstract idea" and a tool as "a device or implement, especially one held in the hand, used to carry out a particular function."

Table 3. Terminological review of the variety of living lab definitions

Characteristics or Perspectives of living labs	Examples of characteristics	Examples of living lab use
Real-life environments	• Environment of experiment [1] • Open innovation environment [42] • Real-life like setting [9,10] and daily life or everyday context [17,26,43] • Experimental or experimentation environment [18,48,54] • (Semi)realistic contexts [32] • Virtual realities [54,64] • Innovation milieu [44] • Development project [1,7] e.g. temporary project • Restricted place e.g. classroom[5], living rooms[2] • Home (prototype) [6,8,13] • Building[16] • Restricted city neighbourhood [3] • Cities [26,72] or Smart City [66] • Regions (city [23], physical [42,64], individual [61]) • Regional innovation system [33] • Rural areas [23] • Country [13]	• Analyse complex problems and exercise component skills [7] • Learning in real-life problems [3] • Capturing, teaching, and learning by ubiquitous computing [5] • Interpret and understand home [6] • Provide information and test prototypes [14] • Dealing with uncontrollable dynamics of everyday life [18,37] • Support enterprises to focus their competencies [41] • Co-creation process for new services, products, and societal infrastructures [42] • Solve current and real world problems [42] • Collaboration for creation, prototyping, validating, and testing of new technologies, services, products and systems [54,58,64,69]
Stakeholders	• Multistakeholder [3,11,54,57,58,64,69] • Users [2,9,10, 21,32,47,51,54,56,58,64,65,69,70], user community [27] • Citizens [22,43,71,72], employee [14], students [3,7], temporary residence [17], public involvement [4] • (Public or local) authorities [22,43,68] or public agencies [54,58,64] • User (as co-producer [19], as innovator [20], as contributors [25] and as co-creators [24]) • Firms [22,54,58,62,64,68,71] • Developers [28] • Research organisations [62], universities [54,58,64,68,69], institutes [54,58,64] • Other stakeholders [28,56,58,64,69]	• Analyse complex problems[7] • Create, prototype, validate and test services business, markets and technologies[22]

Approaches, instruments, methodologies, and tools	• Approaches (integrate theory and practice [15,16], ICT innovation and development [31], open innovation [34], human-centric research and development [24,38,39,50]) • Instrument for innovation [26,51] • Methodology or methods (R&D [20,23,36,61,66], multiple mixed-methods approach [42], multi-method approach [57] • Collaborative placed-based innovation [26,51], quantitative and qualitative research methods [47], design research [67] • Design process [60]	• Create and validate real-world environment[20] • Sensing, prototyping, validating redefining complex solutions[36] • Iterative research process [47] • Support design for user experiences [47] • Take account nature and complexity of different communities, settings and stakeholders [40] • Co-design solutions for complex problems [68]
Concepts or conceptualisations	• Focal point [45] • Platform [63] • Intermediary [29] • Social configuration [49] • Public–private partnerships [22,30] or Public–private–people partnerships [54,58,64,69] (business–citizens–government–academia partnership [43]) • Open innovation (intermediaries [52], platforms [35], paradigm [70]) • Network [46] ,virtual networks [22,30], collaboration networks [53] • System [25,50,59] • Tool (open innovation [45], collaborative system research [15,16], spatial context [56])	• Structuring and providing governance to participation [29] • Multiorganisational and multilevel collaboration [45] • Innovation creation by contact, communication and collaboration [49]

[1] (Knight, 1749) [2] (Billboard, 1956) [3] (Bajgier et al., 1991) [4] (Bengtson 1994) [5] (Abowd, 1999) [6] (Kidd et al., 1999) [7] (Benne & Fisk, 2000) [8] (Intille, 2002) [9] (Intille et al., 2005) [10] (Intille et al., 2006) [11] (Kusiak ,2007) [12] (Moffat, 1990) [13] (Tarricone, 1990) [14] (Lasher et al., 1991) [15] (McNeese et al., 1999) [16] (McNeese et al., 2000) [17] (Markopoulos & Rauterberg, 2000) [18] (Hoving, 2003) [19] (Ballon et al., 2005) [20] (Eriksson, Niitamo & Kulkki, 2005) [21] (Pierson & Lievens, 2005) [22] (Niitamo et al., 2006) [23] (Ponce de Leon et al., 2006) [24] (Ståhlbröst, 2006) [25] (CoreLabs, 2007) [26] (Fahy et al., 2007) [27] (Lacasa et al., 2007) [28] (Schaffers & Kulkki, 2007) [29] (Almirall & Wareham, 2008a) [30] (Feurstein et al., 2008) [31] (Følstad, 2008a) [32] (Følstad, 2008b) [33] (Konsti-Laakso et al., 2008) [34] (Levén & Holmström, 2008) [35] (Luojus & Vilkki, 2008) [36] (Mulder et al., 2008) [37] (Pierson et al., 2008) [38] (Ståhlbröst, 2008) [39] (Ståhlbröst & Bergvall-Kåreborn, 2008) [40] (Schaffers et al., 2009) [41] (Svensson & Ihlström Eriksson, 2009) [42] (Bergvall-Kåreborn & Ståhlbröst, 2009) [43] (Bergvall-Kåreborn et al., 2009a) [44] (Bergvall-Kåreborn et al., 2009b) [45] (Kviselius et al., 2009) [46] (Mulder & Stappers, 2009) [47] (Schuurman & De Marez, 2009) [48] (van der Walt et al., 2009) [49] (Dutilleul et al., 2010) [50] (Lepik et al., 2010) [51] (Schuurman et al., 2010b) [52] (Almirall & Wareham, 2011) [53] (Lievens et al., 2011) [54] (Westerlund & Leminen, 2011) [55] (Edwards-Schachter et al., 2012) [56] (Edvardsson et al., 2012) [57] (Fulgencio et al., 2012) [58] (Leminen et al., 2012a) [59] (Liedtke et al., 2012) [60] (Pallot & Pawar, 2012) [61] (Tang et al., 2012) [61] (Fulgencio et al., 2012) [62] (Guzmán et al., 2013) [63] (Sauer, 2013) [64] (Veeckman et al., 2013) [65] (Ogonowski et al., 2013) [66] (Coenen et al., 2014) [67] (Dell'Era & Landoni, 2014) [68] (Gray et al., 2014) [69] (Leminen & Westerlund, 2014) [70] (Tang & Hämäläinen, 2014) [71] (Molinari, 2011) [72] (Mulder, 2012)

The next subchapter explains characteristics within living lab studies in different streams that represent their underlying assumptions rather than epitomizing the research streams by the identified characteristics.

2.4 Three streams of living lab studies

This subchapter shows a continuum of studies on living labs and their characteristics to represent their underlying assumptions based on the conducted content and terminology review rather than the characteristics per se. More specifically, this study identifies and labels three layered streams of living lab studies and typifies the streams into (i) *a living lab as a context,* which typically refers to studies on living labs, where real-life environments become intertwined with user activities, (ii) *a living lab as a method,* which in turn refers to studies on development approaches, methods, and methodologies and their processes where artifacts are developed, validated, and tested, and (iii) *a living lab as a conceptualisation*, which refers to studies on created conceptualisations and tools, which are suggested for conceptualizing innovation activities in real-life contexts. This study positions itself in the third stream of living lab studies rather than representing a living lab as a context or a living lab as a method. Hence, this study focuses on conceptualisations and tools such as networks, roles, and innovation outcomes in living labs. The study examines such conceptualisations anchored into open real-life environments rather than documenting real-life environments and user activities per se.

2.4.1 A living lab as a context

The studies on living labs often describe a broad variety of real-life environments, where user activities are conducted for benefit(s) of stakeholders. This study labels this stream as *a living lab as a context*. Typically, the first stream of living lab studies focuses on explaining contexts. Such studies describe real-life environments (cf. Tarricone, 1990; Bajgier et al., 1991; Benne & Fisk, 2000) or technology-embedded environments (cf. Kidd et al., 1999; Markopoulos & Rauterberg, 2000; Intille et al., 2002; Intille et al., 2005; Intille et al., 2006), where users are engaged in activities with other stakeholders.

Living labs represent a broad variety of contexts from a single isolated place to broader environments including a learning environment at a school such as a classroom (Abowd, 1999), a building (Lightner et al., 2000; Gwynne, 2008), a home (Kidd et al., 1999; Intille, 2002; Intille et al. 2005; Intille et al., 2006), a sealed greenhouse (Arizona Bubble, 1991), a part of a city (Bajgier et al., 1991; Carroll & Rosson, 2013), a zoo (Benne & Fisk, 2000), a city (Hlauschek et al., 2009), and an industrial plant (Bengtson, 1994; Brouwer, 2002).

This stream of living lab studies often describes user activities for the benefits of stakeholders in living labs. Stakeholders – a company (Bengtson, 1994; Brouwer, 2002) and a university or a research institute (Kidd et al., 1999; Intille, 2002; Intille et al. 2005; Intille et al., 2006; Kanstrup et al., 2010) – utilise living labs for their own needs. Companies and other organisations often apply living labs as a part of their activities to achieve goals that are not otherwise achievable. The activities include testing and developing and other activities related to service and product innovations. For example, Bajgier et al. (1991) apply a living laboratory to enhance student learning in real-world projects in a city neighbourhood. The authors propose that a living laboratory is by nature multidisciplinary because of the complexity of the problems it tackles. The authors also found the need for a multistakeholder involvement and iterative steps (i.e., a feedback loop) in a living laboratory. Also, Benne and Fisk (2000) document the living lab as the learning environment in a temporary development project at a zoo.

Next, Bengtson (1994) illustrates a living laboratory as a mechanism for developing and implementing public involvement in nuclear safety. In contrast, Abowd (1999) provides a detailed description of a living laboratory that captures teaching and learning experiences. The author suggests a revolutionary idea that users can act as developers besides describing usage of technology in a living laboratory setting. In this vein, Benne and Fisk (2000) propose a living laboratory as ‘a concept’ but rather explain the approach in a zoo, where students analyse complex problems and practice their skills. Also, Lightner et al. (2000) document a living laboratory as a building to enhance teaching and learning in the area of engineering. Lacasa et al. (2007) in turn propose that living labs are media contexts that people

use for their own goals. The authors propose to use media contexts for learning in their classrooms.

Kidd et al. (1999) expand the living laboratory to a home. Their premise was an authentic building that supported occupants living and giving feedback from systems. Further, Markopoulos and Rauterberg (2000) lean on their visionary report of living lab research conducted on smart rooms and homes. The authors illustrate a living lab as a building that provides an experimental platform for home-related technologies with a temporary residence. They differentiate living labs from traditional lab settings. The authors further argue that a living lab is not a project but a platform. Similar to Kidd et al. (1999), Intille (2002) establishes a living laboratory to demonstrate building technology with embedded technology and to study physical-digital interaction in a home by evaluating the meaning of pervasive computing for human behaviour in the home (i.e., a real-life environment). Later, Intille et al. (2005, 2006) document the living laboratory as a real-life, lab-like setting to gather data from users´ behavioural use of technology with the help of sensors and formal protocols. Thus, real-life environments incorporate real-life-like settings, daily life and everyday contexts. Besides well-defined areas such as classrooms and homes, studies on living labs have included broader areas of daily life or everyday contexts including a city or a country. In fact, Kanstrup et al. (2010) document an open platform in a city to support learning among all participants. Konsti-Laakso et al. (2008) in turn propose that living lab activities are included as a part of public sector innovativeness in a regional innovation system. Last, Moffat (1990) documents how a single country monitors its citizens to test connections between diet, lifestyle factors and disease.

To sum up the first stream of living lab studies, this study shares the view that living labs are real-life environments and intertwined with user activities rather than positioning itself in the first stream of living labs studies.

2.4.2 A living lab as a method

The second stream of living labs studies represents approaches or methodologies applied in real-life environments. This study labels the stream as *a living lab as a method.* In this stream, living lab studies typically

focus on development approaches, methods and methodologies and their processes, where artefacts such products, services, systems, and their prototypes are developed, validated, and tested with users and multiple stakeholders rather than describing real-life environments intertwining with user activities per se. The second stream of living lab studies offers (i) *methods or methodologies coupled to different contexts,* (ii) *phased, processual methods or methodologies,* and *(iii) differentiation of living labs from other R&D and development approaches*.

First, studies on living labs distinguish *methods or methodologies coupled to different contexts*. For example, Ståhlbröst (2006) focuses on understanding living labs as an action research approach in an IT-design process. She clusters findings in her research including reaching a common purpose, context, innovation, users and needs. The author emphasises the importance of users in technology tests within real-life contexts. Further, Ponce de Leon et al. (2006) propose that a living lab approach is an R&D (research and development) methodology for new services, products or applications to design, test, validate and develop by real consumers and end users in an e-environment. Luojus and Vilkki (2008) in turn propose that a living lab is a real-life environment that engages students in a real-life problem development by a pedagogical method in a university research centre. The authors propose that particularly user-driven research methods start living lab activities. Further, Tang et al. (2012) view living labs as an environment, a methodology, and a system for innovation in an everyday campus life. Lepik et al. (2010) suggest that living labs can be towns, districts, villages, rural areas or industrial zones. The authors describe usages of living lab methods in the Helsinki-Tallinn cross-border region. The authors suggest that living labs create, prototype, validate and test new services, products and systems in real-life environments. Again, Mulder (2012) emphasises citizens' participation when co-developing social innovations for their cities. She reports that living labbing enables citizens' co-development. She identifies a living labbing approach and includes in it service concepts, prototypes and public services as tangible and intangible innovations. In this vein, Coenen et al. (2014) position living labs as an R&D methodology covering both top-down and bottom-up approaches in a smart city context. Pallot and Pawar (2012) take another perspective and characterise a living lab as an iterative experimental design process that shares, crystallises and accumulates

knowledge of stakeholders to enhance user experiences in relation to the Internet of Things. In contrast, Edwards-Schachter et al. (2012) propose living labs as social innovation spaces where a living lab methodology is used to identify user needs, preferences and expectations for innovation opportunities in collaborative contextual innovation. Last, Dell'Era and Landoni (2014) view a living lab as a design methodology and apply the approach to understand user needs in a variety of real-life environments. The authors emphasise that the methodologies benefit a variety of user needs and allow interaction between users, products, and daily lives.

Next, this study elaborates *phased, processual methods or methodologies* documented in studies on living labs. Such studies cover a great variety phases and employed processes to reveal conducted activities. For example, Følstad (2008b) underlines that living labs contribute to the innovation and development process. He further proposes that living labs are contexts and emphasises user involvement in medium- and long-term studies. Levén and Holmström (2008) in turn suggest that a living lab approach supports innovation processes and that living labs are real-life environments that attract versatile stakeholders for delivering results according to their needs.

Pierson and Lievens (2005) identify four phases in a living lab: contextualisation, concretisation, implementation and feedback. The authors propose that living labs are cyclic by nature, and utilise a set of methodologies in different phases. In this vein, Schumacher and Feurstein (2007) differentiate methods of product development at different phases in living labs. The authors propose that the methods partly support users' active participation in living lab activities. Schaffers and Kulkki (2007) continue and document that living labs catalyse rural and regional systems of innovation with developers and other stakeholders. The authors suggested a phased approach to rural area development, which characterises innovation development in the studied seven living labs. Schaffers et al. (2008) propose a 'phased action research approach' to organise innovations in rural living labs. Schaffers et al. (2009) in turn stress a need for using multiple methods and observing the various stakeholder needs in living labs. They claim that the living lab methodology can vary depending upon different user environments. In this vein, Budweg et al. (2011) underline that professional

communities create collaboration practices and tools to facilitate innovations by methodologies used in different phases.

Ståhlbröst (2008) introduces the FormIT methodology and addresses five key principles: continuity[20], openness[21], realism[22], empowerment of users[23], and spontaneity[24]. She concludes that, to identify, inform, interact, iterate, involve, influence, inspire, illuminate, integrate, and implement are ten guidelines for designing living labs. In accordance with her, Ståhlbröst and Bergvall-Kåreborn (2008) describe an iterative FormIT process, which consists of three main phases: discovery, design and evaluation. Next, Holst et al. (2010) apply the FormIT methodology (cf. Ståhlbröst, 2008) to design three iterative phases to characterise openness. They propose that openness significantly improves and fastens innovation.

Also, Guzmán et al. (2013) document that living labs include a process reference model for user-driven innovation including incubation, conceptualisation, prototyping and validation phases, where participants maximise socioeconomic conditions of partnerships. Tang and Hämäläinen (2014) propose an additional, similar process model, which has five iterative phases: requirements, co-design, prototyping, test and tracking, and commercialisation. The authors conclude that a living lab is a bridge between open innovation and community innovation, links different stakeholders, and is an iterative process model. More specifically, living labs apply a broad variety of methodologies and concepts including ICT–embedded real context methods, ICT-adapted laboratory methods, traditional laboratory methods,

[20] Continuity refers to collaboration over a series of projects, innovation cases and business experiments that build trust between people to strengthen creativity and innovation (CoreLabs, 2007, p.10; Ståhlbröst 2008, 110).
[21] Openness refers to opening the innovation process to accelerate development processes and to gain many unforeseen benefits (CoreLabs, 2007, 10; Ståhlbröst 2008, 110).
[22] Realism refers to realistic behaviour of users and stakeholders in a real-life environment or a natural environment, which enables the generation of valid results for real markets (CoreLabs, 2007, 11; Ståhlbröst 2008, 111).
[23] Empowerment of users refers to engagement of the creative power of users and their needs and desires in the innovation process (CoreLabs, 2007, 11; Ståhlbröst 2008, 111).
[24] Spontanity refers to the "*ability to detect, aggregate and analyze spontaneous user's reactions and ideas over time, along a product/service full lifecycle over-time*" (CoreLabs, 2007, 11).

and traditional real context methods (Tang & Hämäläinen, 2014). Furthermore, Ogonowski et al. (2013) document one of the few longitudinal living lab studies with subsequent phases, where the same users participated in co-creation and design activities covering a variety of research methods throughout a three-year period, where the same users were involved for the whole span of the development project. The authors conclude that trust and collaboration increased between user and stakeholder parties along the whole span of the development project. Gray et al. (2014) found that living labs are appropriate for co-designing complex problems by complex communities. The authors show that different contexts may benefit from using different methodologies; they also document that different phases may benefit different methodologies.

Last, studies on living labs *differentiate living labs from other R&D and development approaches*. For example, Bergvall-Kåreborn et al. (2009a) show a difference between living labs and systems development and field studies. The authors argue that living lab activities are carried out in authentic use situations (i.e., real-life environments) in opposite to systems development. The authors further claim that living labs involve all stakeholders and include stakeholders as close co-operators (i.e., partners) and incorporate close relations of living labs to academia and users. Further, Bergvall-Kåreborn and Ståhlbröst (2009) underline that real users (i.e. 'realism') as one of three principles in real-life situations in a living lab network. The principle differentiates living labs from traditional systems development. Next, Bergvall-Kåreborn and Ståhlbröst (2009) propose that action research is a well-established methodology in social sciences and can be employed in living labs. Similar to action research, living labs share interactions between theory and practice. For example, McNeese et al. (1999) propose that a living lab or a living laboratory is an approach to integrate theory and practice in real-world simulations. Wilson et al. (2008, 115) emphasise this differently as "*bringing research into reality rather than reality into research*". Next, Wellsandt et al. (2012) depict that a traditional lab calls users for participation in testing or innovating activities in a laboratory environment whereas a living lab provides needed technology for their own activities.

Eriksson et al. (2005) suggest that living labs typically have high degrees of participation and in multiple and emerging contexts (Figure 2). Edvardsson et al. (2012) in turn distinguish a living lab as a method containing many tools for customer involvement and a context for user innovation. Eriksson et al. (2005) include users as innovators and emphasise a central role of users in innovation by following Thomke and von Hippel (2002). Eriksson et al. (2005) propose that there are different stakeholders such as users, public, academia and firms in living labs. The authors stress the need for iterations, trial and error in co-design when applying human-centric approaches in living labs. The authors propose that a living lab generates solutions to problems and novel ideas based on the business model. They share the view that living labs are a "*context for user innovation"* (Eriksson et al., 2005, 424). In contrast to many studies on living labs, the authors claim that living labs create circumstances to simulate and generate information with users.

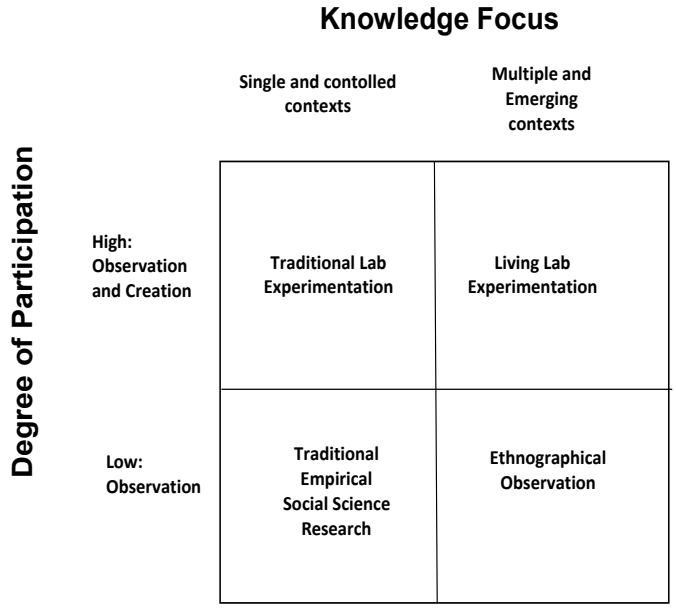

Figure 2. Participation and context of innovation (Eriksson et al. 2005, 7)

Edvardsson et al. (2012) differentiate living labs as 'in situ' (i.e., in a customer's use situation) and 'ex situ' (i.e., outside the use situation). Mulder and Stapper (2009) take another perspective and differentiate a 'lab' and a

'living' part in a living lab. The authors propose that the lab refers to the usage of traditional methods, whereas the living part is connected to "methods of participation and co-creation". The authors argue that a living lab differs from other cross-disciplinary approaches: living labs focus on interaction with users in a real-life environment. They claim that the different approaches influence each other and living labs increasingly need generative techniques; therefore, the authors integrate living labs into human-centered research by applying a categorisation of Sanders and Sapper (2008), as shown in Figure 3.

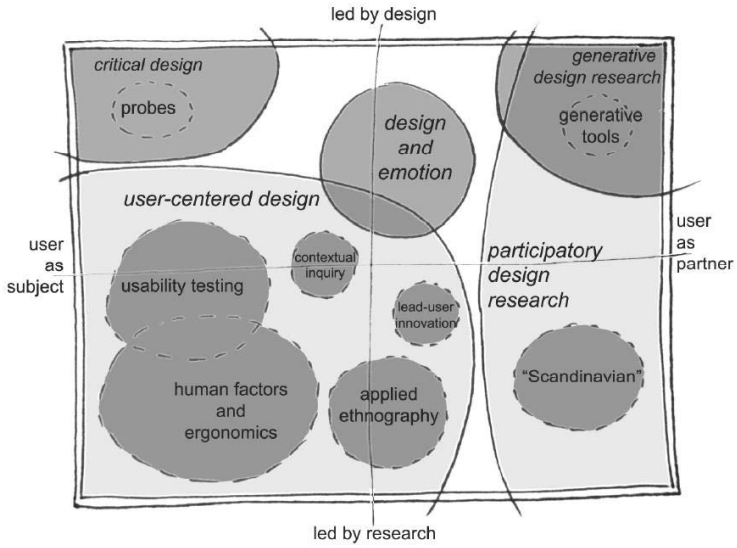

Figure 3. The current landscape of human-centered design research as practiced in the design and development of products and services (Sanders & Sapper 2008, 6)

Pallot et al. (2010) provide another extensive classification – a domain landscape of a 'living lab research map' – and they differentiate the landscape by two dimensions: research type and interaction mode. The authors add collaboration styles and evaluation focus to elaborate the map of user methodologies but fail to clearly position living labs. Almirall et al. (2012) in turn position living labs in a landscape of user-contributed methodologies. The authors form a two-dimensional framework. The vertical dimension refers to 'involvement of users' in a co-creative process that has two extremes: 'users as subject of study' and 'users as co-creators'. A horizontal dimension in turn differentiates contexts: the 'lab-like settings'

and 'real-life environment'. Almirall et al. (2012) identify the following four categories and descriptions of innovation methodologies in living labs (Figure 4):

1. *User centered*. Users are seen as subjects of a study. Usability testing, human factors, and applied ethnography apply a user-centered approach.
2. *Design driven*. Design-driven technologies are led by designers in real-life environments.
3. *Participatory design*. A participatory design grounds on the assumption that users are equal partners in a co-creative process. Participatory design and generative design apply this methodology.
4. *User driven*. Users are active players in innovation process. Open source, lead users and living labs often apply this approach.

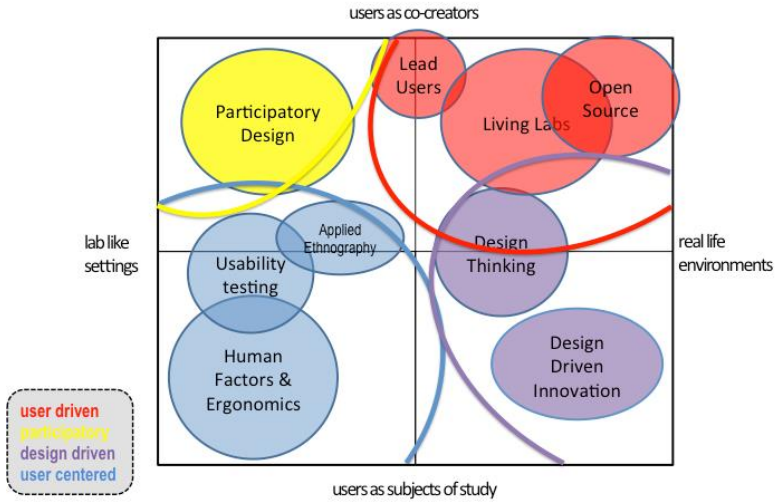

Figure 4. Living lab methodologies (Almirall et al. 2012, 16)

To sum up, the second stream of living labs studies typically focuses on development approaches, methods and methodologies and their processes. The second stream of living lab studies documents living labs as phased approaches and assumes that such predetermined phases exist. In contrast, this study takes another perspective and underlines that subsequent

innovation activities in living labs often depend on results of extant innovation activities with users and stakeholders rather than following predetermined phases per se.

Many studies in different streams of living labs incorporate a broad variety of living lab activities in their definitions of living labs such as creating, prototyping, validating and testing (cf. Pierson & Lievens, 2005; Niitamo et al., 2006; Mulder et al., 2008; Westerlund & Leminen, 2011; Guzmán et al., 2013). The present study shares the view of the second stream of living lab studies that living labs are characterised by real-life environments and user involvement. Thus, living labs are different from other R&D and development approaches. However, many studies document that living labs may apply a broader variety of methodologies (cf. Schaffers et al., 2009; Budweg et al., 2011; Gray et al., 2014) that were originally applied in other R&D and development approaches. Therefore, the present study underlines that living labs assume real-life environments and user involvement that are different from other R&D and development approaches as shown in Almirall et al. (2012), but living labs may employ other R&D and development approaches as a part of the innovation activities rather than relying solely those other approaches. This study underlines that the 'living lab as a method' research stream is different than the methods or research design upon which scientific studies are grounded. The 'living lab as a method' research stream explains the focus on the living lab as the object of study rather than referring to research design in studies of living labs.

2.4.3 A living lab as a conceptualisation

The third stream of living lab studies represents a broad variety of real-life innovation constellations for conceptualizing innovation activities in real-life contexts. The study labels this stream as *living labs as a conceptualisation*, where living lab studies typically focus on conceptualisations of innovation activities in real-life environments. In other words, living labs as a conceptualisation focuses on understanding living labs by conceptualising living labs by different means including archetypes and versatile typologies of living labs such as systems, structures of living labs, user and stakeholder roles and other concepts rather than focusing on development approach or contexts per se. The real-life environments and methods and methodologies may be argued to be conceptualisations as well. However, a

conceptualisation of the 'word', real-life environment focuses on explaining such contexts rather than the third stream. This study underlines that conceptualisations of methods and methodologies in turn focus on explaining such development approaches rather than abstracting or reaching beyond to the development approaches, methods and methodologies on living labs.

The literature on living labs distinguishes a broad variety of constellations with multiple characteristics, where the premises of such studies propose multiple characteristics for living labs rather than single ones (cf. Corelabs, 2007; Mulder et al., 2008; Fulgencio et al., 2012). Among them, Fulgencio et al. (2012) characterise a living lab as "multi", meaning that it covers multi-mode, multi-stakeholder, multi-discipline, multi-method, and multi-cultural aspects.

The third stream of living lab studies proposes many concepts in living labs including *focal point* (Kviselius et al., 2009), *intermediary* (cf. Lasher et al., 1991; Almirall & Wareham, 2008a; Almirall & Wareham, 2011), *innovation arena* (Almirall & Wareham, 2008a), and *platform* (cf. Ballon et al., 2005). Such studies couple stakeholders to organise innovations in living labs. For example, Lasher et al. (1991) depict a living lab as an *intermediary* that integrates a development project in a partnership between an IT-supplier and its customer. The authors document a user group in a living lab and illustrate how internal employees provide information and test prototypes. Almirall and Wareham (2008a) share the view that living labs are intermediary, where they found that living labs act as a connector but also organise users in innovation activities. Later, in this vein, Almirall and Wareham (2011) redefine living labs as open innovation intermediaries that mediate users, researchers, and public and private organisations. Almirall and Wareham (2008a) further propose that living labs are both *innovation arenas* and innovation intermediaries for the user and that societal involvement has an important role in systems of innovation. The authors emphasise two main ideas: involving users in innovation and experimentation in real-world settings in living labs. Kviselius et al. (2009) in turn propose that a living lab is both a tool for open innovation and a *focal point* for multi-organisational and multi-level collaborations. The authors

stress the importance of motivating and activating users but also other stakeholders for innovation activities.

Many studies distinguish living labs as *platforms* and underline that living labs are different than test beds (cf. Ballon et al., 2005; Følstad, 2008a; Salminen et al., 2011). Ballon et al. (2005) claims that living labs reconstruct natural user environments and are thus different from in-house R&D, open innovation platforms and pilots. Living labs provide a platform, methodology and settings for innovation activities (Sauer, 2013). In this vein, Molinari (2011) underlines that living labs are multistakeholder platforms for innovations and that living labbing is the local stakeholders' effort to strengthen a culture of innovation.

In addition to the above discussed forms and structures in living labs, the extant studies on living labs study propose *systems and networks* in living lab (cf. McNeese et al., 2000; Corelabs, 2007; Feurstein et al., 2008; van der Walt, 2009; Dutilleul et al., 2010; Lievens et al., 2011; Leminen et al., 2012a; Liedtke et al., 2012). Feurstein et al. (2008) document a living lab as a networked approach that integrates stakeholders in product and service development and facilitates multi-contextual dimensions. Hence, a living lab, by definition, consists of different actors, where networks and systems distinguish the constellations of multiple actors. McNeese et al. (2000) suggest that a living lab is a socio-technical system design and is associated with outcomes including tools, ethnographic studies, paradigms/models, prototypes, and scaled world simulations. Corelabs (2007) in turn proposes that a living lab is a system that focuses on engagement and empowerment of users for generating assets for partners and customers in living labs. Corelabs (2007) suggest five key principles on living labs: continuity, openness, realism, empowerment of users, and spontaneity. Next, van der Walt (2009) proposes a systems thinking perspective (i.e., interpreting interrelationships within systems by describing living labs). In this vein, Liedtke et al. (2012) stress that a living lab is a techno- and socio-economic system focusing on social needs of people paying regard to sustainable development. The authors propose that users are engaged in innovation development rather than being used as a source of innovation in living labs; in other words, living labs actively engage users rather than trying to 'design around them'.

Fahy et al. (2007) address that living labs are a part of a wider innovation system. The author claims that living labs provide many services to all their stakeholders. Last, Dutilleul et al. (2010) take another perspective and view living labs as *social constructions* to organise innovations. The authors encompass these different categories to different settings and trials. The authors refer to a setting as a physical or social setting and a trial as an activity within a product development process. Dutilleul et al. (2010) view the network of living labs as an innovation system. Lievens et al. (2011) propose a phased methodology framework including building, evaluating, justifying and generalizing in living labs. The authors find that living labs are cross-border collaboration networks that promotes direct communication between stakeholders and have internal transparency. Niitamo et al. (2006) propose a regional, national or European-wide network of living labs. In this vein, Westerlund and Leminen (2011) include regional and global networks for living labs. The authors document a multi-actor perspective in living labs, where different stakeholders – a user provider, an enabler and a utilizer – exist. Leminen et al. (2012a) propose that a driving actor differentiates living labs. Different types of living labs networks (i.e., utilizer-driven, enabler-driven, provider-driven, and user-driven living labs) differ by their key characteristics including purpose, organisation, action, outcome, and lifespan.

Numerous studies include multiple stakeholders and particularly users in the literature on living labs. Studies suggest user typologies (cf. Pierson et al. 2008; Schuurman et al., 2010b). Among them, Pierson et al. (2008) typify archetypes of users in living labs, where they deal with uncontrollable dynamics of everyday life. Studies on living labs often propose stakeholders such as a user, a provider, an enabler and a utilizer (cf. Westerlund & Leminen, 2011). The premise of such studies assume that individual stakeholders have particularly implicit role(s), which are explicitly documented by activities. Studies often include a multi-actor perspective; for example, Westerlund and Leminen (2011) include multiple actors when revealing regional and global living lab networks. Kusiak (2007) underlines that living labs rely on a multi-role and multi-faced involvement of customers. However, studies that attempt to understand stakeholder and user roles are limited. For example, Hoving (2003) proposes that users are

co-producers of innovations, where the living lab grounds on user needs from the uncontrollable dynamics of daily life. CoreLabs (2007) proposes that users may take *roles* as contributors and co-creators in innovation activities. Sauer (2013) in turn involves designers, testers, and co-creators as user roles in living labs.

Surprisingly, there are only a few scattered studies on *innovation outcomes*, even though living labs are interlinked to innovation activities by their definitions. For example, Kusiak (2007) uses probably one of the most common classifications of innovation in proposing that both incremental and radical innovations exist in living labs. Even Mulder et al. (2008) propose that living lab is a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real- life contexts. This dissertation takes another stance and views that their study represents the third stream. Hence, Mulder et al. (2008) underline that a living lab consist of six elements (i.e., user involvement, service creation, infrastructure, governance, methods & tools and innovation outcomes) composing the harmonisation cube of living labs, where the authors include knowledge, new products and services or intellectual property rights in innovation outcomes.

Svensson and Ihlström Eriksson (2009) document a classification of innovation ranging from incremental and radical to modular and architectural innovations in living labs. Almirall and Wareham (2011) in turn find a mix of incremental and radical innovations in living labs, where the authors couple innovations to exploitation[25] and exploration[26] in real-life environments. The authors claim that innovations are 'skewed' toward incremental innovations. Veeckman et al. (2013) document outcomes of living labs coupled with the living lab environment and the approaches. Last, Leminen and Westerlund (2014) include a variety of innovation outcomes including incremental and radical innovations in different living labs, which consist of multiple stakeholders and differ by contexts. The authors identify nine different strategies organisations may apply to pursue a variety of

[25] Exploitation includes efficiency, implementation, execution, production, selection, choice and refinement (March, 1991).
[26] Exploration includes capturing, discovering, generating, and creating new knowledge and competences, which are achieved by variation, risks, experiments, plays, flexibility, and innovation (March, 1991).

innovation outcomes in different living labs, which consist of multiple stakeholders and differ by contexts.

2.5 Summarizing meanings and interpretations of living labs

This study typifies the living lab studies in three different streams: (i) *a living lab as a context*, (ii) *a living lab as a method*, and (iii) *a living lab as a conceptualisation*. Table 4 summarises the prior discussed three streams of living labs and their characteristics. The first stream, *a living lab as a context,* explains that real-life environments intertwine with user activities. It portrays a landscape of living labs with users and stakeholder activities. The second stream, *a living lab as a method,* documents and explains methods and methodologies as a part of innovation activities. It suggests many 'roadmaps' by which living labs and their stakeholders navigate through innovation activities in real-life environments. Such roadmaps view and explain methods and methodologies in living labs but also couple methods and methodologies to phases or processual approaches in living labs and differentiate living labs from other R&D and development approaches. The third stream, *a living lab as a conceptualisation,* goes a step further to develop and understand the essence of living labs, their portrayed landscapes, and their suggested roadmaps. Such studies conceptualise living labs by different means. For example, the third stream of living labs studies portray conceptualisations on systems, networks, and many other forms and structures representing living labs. Such forms and structures include user and stakeholder roles, and innovation outcomes rather than explaining users and stakeholders in living labs and developed products and services per se. The third stream of living labs studies often provides conceptualisations for the benefit of both scholars and researchers to further understand living labs as a theoretical construct but also offers many conceptualised tools for living lab activities for the benefit of practitioners.

At first glance, the three research streams include seemingly similar characteristics because all three streams share the view that living labs are real-life environments, emphasise importance of users, have multiple stakeholders and ground on collaborations between stakeholders (see Table 4). Even though physical regions are particularly dominant in the "living labs as a context" research stream, this study proposes that different contexts

such as 'physical regions', 'virtual realities' or 'interaction spaces' do not determine the research streams. Hence, physical regions are seen as a context of studies in the two remaining research streams as well. Further, some earlier studies identify virtual realities as real-life contexts (cf. Niitamo et al., 2006). Guzmán et al. (2013) and Edvardsson et al. (2012) in turn refer them as a processual approach, whereas Feurstein et al. (2008), Westerlund and Leminen (2011), and Leminen et al. (2012a) include virtual realities as a part of definitions in the studies of networks. Interaction spaces in turn are merely implicitly referenced, when discussing the interactions of stakeholders in living labs (cf. Intille, 2002). This study underlines that the three stream of living lab studies differ by each other as concluded in Table 4 by characteristics of living labs, their underlying assumptions, and examples of conducted studies. Thus, the focuses of research streams vary as discussed earlier in Chapter 2.4 and its subsequent subchapters and shown in Figure 5.

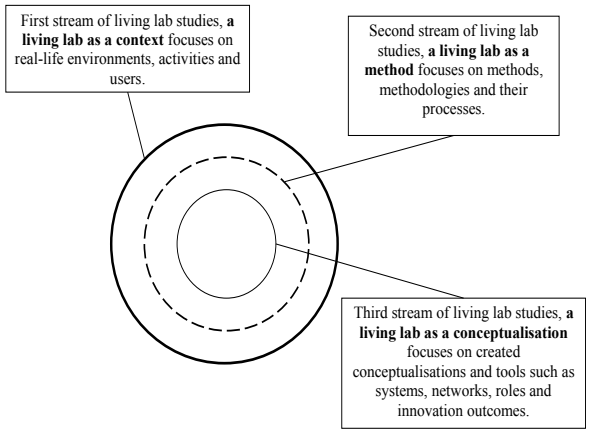

Figure 5. Layered streams of living labs studies

This study puts a living lab as a context to an outer layer, a first stream of living lab studies, because real-life environments, activities, and users are visible and such characteristics are included in all the three different living lab streams. The next, second stream of living lab studies, a living lab as a method, focuses on methods and methodologies and their processes where

such perspectives reveal living labs in more detail. The last, third stream, a living lab as a conceptualisation, focuses on created conceptualisations and tools to further understand living labs, which are not tangible per se but may be seen through examples of activities and behaviours of stakeholders in living labs.

Bergvall-Kåreborn and Ståhlbröst (2009) propose that prior studies define living labs as an environment, a methodology and a system. The authors claim that such definitions are not contradictionary, rather they are complementary. The present study underlines that the three archetypes of living labs streams should be understood as layered streams, where the later stream(s) fully or partially cover the characteristics of a prior stream. In accordance with the complementary perspective of Bergvall-Kåreborn and Ståhlbröst (2009), the present study explains studies on living labs by their underlying assumptions rather than solely and 'mechanically' incorporating the single characteristics. For example, Bergvall-Kåreborn and Ståhlbröst (2009) and Bergvall-Kåreborn et al. (2009b) explicitly document a living lab as a method, focusing on processes and phases in living labs. Their study could be interpreted as a living lab as a conceptualisation because the authors refer to the system and network perspectives of living labs. However, the present study proposes that the studies of Bergvall-Kåreborn and Ståhlbröst (2009) and Bergvall-Kåreborn et al. (2009b) are part of the second stream of living lab studies because they focus on differentiating living labs from other R&D and development approaches. In other words, this study draws the line between the research streams and typifies the living lab studies on different streams, which include their typical characteristics but incorporate the focus illustrating three streams of studies.

This study exemplifies the research streams of living lab studies. More specifically, chapter 2.4.3 offers a limited view of the third stream, a living lab as a conceptualisation, rather than covering comprehensive and in-depth descriptions of conceptualisations from the three research questions perspectives, namely living lab networks, roles, and innovation outcomes in living labs. Therefore, this study continues to reveal and conclude the theoretical background on living labs and particularly from the three selected perspectives on living labs in order to have more vivid and in depth understanding on living labs. Given that the living lab research consists of

layered research streams, the next chapter focuses on studies from the third stream of living lab literature, but may also take account some characteristics such as stakeholders and activities discussed in the two prior research streams to reveal the three perspectives of the study. The next chapter, Chapter 3, describes networks, roles, and innovation outcomes in living labs.

Table 4. Continuum of studies on living labs

Continuum of living labs	Characteristics of living labs	Underlying assumptions	Examples
A living lab as a context	• Real-life environment • Activities • Users (stakeholders)	Living labs represent a broad variety of real-life environments, where the environments and activities are intertwined for the benefit(s) of stakeholder(s).	*Variety of real-life environments* Moffat 1990, Tarricone 1990, Bajgier et al. 1991, Benne & Fisk 2000, Konsti-Laakso et al. 2008 *Technology-embedded environments* Kidd et al. 1999, Markopoulos & Rauterberg 2000, Intille et al. 2002, Intille et al. 2005, Intille et al. 2006
A living lab as a method	• Development approaches (methods, methodologies, and their processes) • Real-life environment • Activities • Users and stakeholders	Living labs represent development approaches, methods and methodologies and their processes, where artefacts such as products, services, systems, and their prototypes are developed, validated, and tested with users and multiple stakeholders.	*Methods or methodologies coupled to different contexts* Ponce de Leon et al. 2006, Ståhlbröst 2006, Levén & Holmström 2008, Luojus & Vilkki 2008, Lepik et al. 2010, Mulder 2012, Pallot & Pawar 2012, Tang et al. 2012, Coenen et al. 2014, Dell'Era & Landoni 2014 *Phased, processual methods or methodologies* Pierson & Lievens, 2005, Schumacher & Feurstein 2007, Schaffers & Kulkki 2007, Følstad 2008a, Schaffers et al. 2008, Ståhlbröst 2008, Ståhlbröst & Bergvall-Kåreborn 2008, Schaffers et al. 2009, Holst et al. 2010, Budweg et al. 2011, Guzmán et al. 2013, Ogonowski et al. 2013, Gray et al. 2014, Tang & Hämäläinen 2014 *Differentiations living labs to other R&D and development approaches* Eriksson et al. 2005, Bergvall-Kåreborn et al. 2009a & 2009b, Bergvall-Kåreborn & Ståhlbröst 2009, Mulder & Stapper 2009, Pallot et al. 2010, Almirall et al. 2012, Edvardsson et al. 2012

A living lab as a conceptualisation	• Conceptualisations • Real-life environment • Activities • Stakeholders and users	Living labs represent a broad variety of created conceptualisations of innovation activities in real-life contexts.	*Network(s)* Niitamo et al. 2006; Feurstein et al. 2008, Dutilleul et al.2010, Lievens et al. 2011, Westerlund & Leminen, 2011; Leminen et al. 2012a *System(s)* McNeese et al. 2000, Fahy et al. 2007, Corelabs 2007, van der Walt 2009, Dutilleul et al. 2010, Liedtke et al. 2012 *Other forms and structures* *Focal point (*Kviselius et al. 2009), *Intermediary* (Lasher et al. 1991, Almirall & Wareham 2008a & 2011), *Innovation arena* (Almirall & Wareham, 2008a), *Platform (*Ballon et al. 2005, Følstad 2008a, Molinari 2011, Sauer 2013 *Stakeholder and user roles* Hoving 2003, Corelabs 2007, Sauer 2013 *Innovation outcomes* Kusiak, 2007, Mulder et al. 2008, Svensson & Ihlström Eriksson 2009, Almirall & Wareham 2011, Veeckman et al. 2013, Leminen & Westerlund 2014, Molinari, 2011

3. Networks, roles, and innovation outcomes in living labs

This chapter shows the three perspectives of living labs in this study: networks, roles, and innovation outcomes. It first distinguishes living labs as networks including classifications of innovation networks including the various types of living lab networks as well as actor, activity and resource perspectives. Next, the chapter discusses roles in living lab networks, covering both roles and role dynamics in innovation networks but particularly in living lab networks. The chapter concludes by discussing tangible and intangible outcomes, and the types of innovations in living labs.

3.1 Living labs as networks

This subchapter briefly describes innovation networks as *centralised*, *decentralised* and *distributed* network structures. It continues by distinguishing five different types of living labs including *a network of living lab networks*, a *living lab in innovation system*, *a cross-border living lab network, a dual living lab network*, and *a single living lab network having multiple stakeholders*. Finally, the chapter concludes by discussing the role of the *actor, activity, and resources perspectives* in different studies of living labs.

3.1.1 Introduction to innovation networks

The literature classifies innovation networks[27] in divergent ways. These classifications suggest that innovation networks incorporate a position and network configuration (Doz, 2001), a density and an average path length (Lazer

[27] *Oxford Dictionary* defines a network as "*arrangement of intersecting horizontal and vertical lines: a spider constructs a complex network of several different kinds of threads", or group or system of interconnected people or things*".

& Friedman, 2007) as well as governance and participation (Pisano & Verganti, 2008), among many others.

Innovation networks have different forms and structures. Such network structures are increasingly evolving and reflecting changes in industries (Low, 2007). Open innovation networks rely on co-creation principles for creating value for companies and their customers, user innovation networks are built up horizontally for users (Chesbrough, 2003; von Hippel, 2007). Pisano and Verganti (2008) in turn identify diverse collaborative modes in open and closed innovation networks and distinguish them by governance ('hierarchical' versus 'flat') and participation ('open' versus 'closed') in networks. The authors label innovation networks as: an 'innovation mall' (an open and hierarchical network); 'elite circle' (a closed and hierarchical network); an 'innovation community' (an open and flat network); a 'consortium' (a closed and flat network).

From innovation network classifications, this study applies the network structure classification suggested by Doz (2001) and Barabasi (2002) because the classification is widely accepted and used. According to Doz (2001), the structure of a network and a firm´s position can be used to characterise business networks. A focal business network distinguishes a network configuration, whereas the company has a central role and acts as a hub or an engine. The present study distinguishes it as a hub company. In opposite to that, a company may act as a node: a role in which it is collaborating with the hub of the network. This study depicts the company as a node company. Barabasi (2002) proposes that networks are *(1) centralised*, *(2) decentralised* or *(3) distributed*.

Doz (2001) labels the *centralised network configuration* as the *hub-and-spoke structure*, whereas a single company typically controls and monitors activities as well as selects partners into the centralised network. The literature explains centrality in networks by different means. For example, Low (1997) stresses that network positions distinguish firms relative to other firms in networks. He proposes that a central network position enables a firm to act and adapt the emerging network by creating and influencing business relationships. Bell (2005) in turn proposes that the centrality measures the involvement of actors in a network, whereas a variance of centrality in networks differentiates and creates different network structures (Gibbons, 2004). According to Chiu (2009), a company's central network position improves innovation performance over

companies having a low network centrality. Jansen et al. (2006) indicate that centralisation negatively affects exploratory innovation. The authors find that exploratory innovations are more beneficial in a dynamic environment. Ojasalo (2008) concludes that an innovation network need an authority that coordinates co-operation, regardless of whether the network has a focus on profit maximation or has less profit orientation. In opposite to that, Dhanaraj and Parkhe (2006) emphasise that hub firms orchestrate network activities without having hierarchical authority in the network. The authors further stress that orchestration includes knowledge mobility, innovation appropriability, and network stability and effects innovations in network. Such network activities includes in a distributed network structure.

Doz (2001) labels the *decentralised network configuration* as a *hub-and-node structure*. In opposite to the centralised network configuration, the hub of the network does not directly control all the nodes in the decentralised network but its own nodes, the so-called first-tier relationships. Thus, the hub company influences the emergence of the decentralised network by selecting its own nodes. The decentralised network has nodes, which constitutes their own hub-and-spoke structures, the so-called second-tier relationships. These hub-and-spoke structures are controlled and monitored by their own hub companies by selecting their own nodes and distributing resources in the networks, the so-called third-tier relationships.

Doz (2001) labels *distributed network configurations* as *multiplex network structures*. In opposite to a centralised network configuration and a hub-node structure in a decentralised network configuration, actors do not have the power or willingness to control business activities conducted by other actors in multiplex network structures. Further, a multiplex network structure is grounded on an assumption that actors are equal and can select appropriate partners for their activities. However, there is one actor who focuses on coordinating and facilitating networking across the multiplex network structures. Lazer and Friedman (2007) identify the 'totally connected' network, which is a rather similar network structure as the distributed multiplex structure, but without a hub-node structure. In addition to the totally connected network, Lazer and

Friedman (2007) propose two additional types of networks: 'linear[28]' and 'random[29]'. Such networks partially illustrate a totally connected network. The authors propose that specific networks focus on certain problems by pooling actors' abilities. These networks are grounded on different purposes and goals for creating and capturing value for divergent stakeholders. Lazer and Friedman (2007) emphasise an old finding that centralised networks are beneficial for simple problem coordination, whereas decentralised networks are utilised for complicated problems. Lay and Moore (2009) suggest another classification of networks including *collaborative* and *coordinated networks*. The former (collaborative networks) have high complexity. These networks focus on innovations and are organised around a hub. The latter (coordinated networks) focus on efficiency, emphasising a high volume, and are organised around a concentrator. Such classification emphasises that network structures are organised by different means.

To sum up innovation network classifications, diverse innovation networks assume various forms and require different structures for desired activities and outcomes. This study applies the network structure classification by Doz (2001) and Barabasi (2002) including centralised, decentralised and distributed networks. A centralised network is often associated with monitoring or controlling partners in the network, decentralised and distributed networks assume flexibility to organise activities in networks. In the next subchapter, a specific form of open innovation networks– living lab networks – are depicted in more detail.

3.1.2 Living lab networks

The scholarly literature puts forward five approaches to examining living lab networks: (1) *a network of living lab networks* (Mavridis et al., 2009; Dutilleul et al., 2010), (2) a *living lab in innovation system* (Dutilleul et al., 2010), (3) a *cross-border living lab network* (Lievens et al., 2011), (4) a *dual living lab*

[28] A linear network *"is a set of nodes in which each node, except for two, communicates with two other nodes, and the nodes and their relationships are arrayed linearly"*, (Lazer &Friedman, 2007, 3).
[29] Lazer and Friedman (2007, 3-4) refer to a random network in which each node may be connected to other nodes; such a network structure is identical to a full network structure if all nodes are connected.

network (Leminen & Westerlund, 2014), and (5) *a single living lab network having multiple stakeholders* (Feurstein et al., 2008),

(1) *A network of living lab networks* refers to living lab networks coupled to other living labs to exchange ideas or strengthening their capacity to provide services such as validating and developing products, services and systems (Mavridis et al., 2009; Dutilleul et al., 2010). Feurstein et al. (2008) propose that living labs form networks in a region. The authors claim that such networks form a basis of European innovation systems. Niitamo and Leminen (2011) in turn identify an emergence of national, country-level living labs and exemplify the national living lab networks in Finland, Sweden, The Netherlands, and Spain. Further, Dutilleul et al. (2010) address the emergence of a European living lab movement because living labs often consider themselves as part of that the living labs movement (Eriksson et al., 2005; Niitamo & Leminen, 2011). The European Network of Living labs (ENoLL) represents a European-level network of the living lab network. ENoLL is further emerging, and many of its new living lab members are from Asia, Africa as well as South America and North America rather than from European countries. Thus, ENoLL can be considered as representing the global network of the living lab networks. The network of the living lab networks is often loosely coupled and does not have any formal power to direct or control activities in its network; rather, the living lab network relies on mechanisms for influencing and monitoring the interests of living labs, especially funding bodies such as the European Commission.

(2) Dutilleul et al. (2010) identify *living labs in innovation systems*. Living labs are argued to be essential parts of innovation systems (Fahy et al., 2007; Ballon et al., 2011) or regional innovations (Rasanen, 2012; Juujärvi & Pesso, 2013). Molinari (2011) suggests that living labs act as an instrument for regional policy to foster innovation. In contrast, Cleland et al. (2012) propose that living labs are often disconnected from national innovation policy. However, living labs are typically subsidised by a governmental or regional fund, where the innovation district supports a market mechanism for living labs (Cosgrave et al., 2013).

(3) A *cross-border living lab* network refers to living labs often nearby to each other in various countries. Such living labs can together offer a broader spectrum of services but also strengthen their resource capacity. Lievens et al. (2011) suggest that living labs are cross-border collaboration networks that promote direct communication between stakeholders and have internal transparency. The cross-border living labs are proposed to enhance co-operation and regional integration across borders (Lepik et al., 2010). Living labs often have immature practices and an absence of commonly accepted ways of working, which jointly impede activities in cross-border living labs (Shampsi, 2008).

(4) *A dual living lab network* refers to a network where two living labs have specific tasks and these living labs together form a joint living lab network (Leminen & Westerlund, 2014). The tasks of providers are dedicated to certain stakeholders, which are specified to handle those activities in both living labs. This arrangement means that a single living lab is not able to provide all innovation development activities and needed tasks in its living lab; the other living lab and its stakeholders are needed to fill that gap.

(5) *A single living lab network having multiple stakeholders* is perhaps the earliest identified living lab type. Dutilleul et al. (2010, 70) label *"observation and experimentation on a living social system"* as in vivo experiment on social systems. The authors identify two additional types of living labs: involving users in innovation and product development approaches as well as facilitating organisations within a single living lab network. Thus, the majority of the earlier stream of living lab literature emphasises involving users in innovation and product development approaches, whereas present living labs cover multiple different stakeholders such as academia (universities and research centres), industry, citizens, users, and public and private organisations utilizing, funding or following activities in living labs (Mirijamdotter et al., 2006; Feurstein et al., 2008). Further, multitude benefits and motivations are emphasised for users and user communities but also for other stakeholders such as researchers and business practitioners when in or joining into a living lab network having multiple stakeholders (Feller & Fitzgerald, 2002).

Even though the literature on living labs identifies living labs as networks, there are surprisingly few attempts to illustrate network structures of living lab networks. Among the few attempts, studies have described the relationships of actors in living labs rather than drawing network structures per se. For example, Vontas and Protogeros (2009) visualise personal connections between seven living labs in a social network of living labs; thus, living labs are a network of networks having both cross-country and cross-living-lab relationships. Next, Lievens et al. (2011) illustrate the social connections of a community developing social and media services during the time span of a project. Dong et al. (2011) in turn take a longitudinal perspective and describe spatial-temporal patterns of residents to identify behaviour and social networks in a student dormitory at the Massachusetts Insitute of Technology. Further, Pallot et al. (2013) attempt to illustrate people concepts networking (PCN), where things are identified and related to content and are shared among stakeholders in living labs. Last, Dekkers (2011) characterises living lab networks by collaboration, decentralisation, inter-organisational integration, technological capabilities and management of living labs.

To sum up, the literature on living labs identifies different types of living lab networks and relationships between actors in living lab networks to employ innovation practices grounded on open innovation principles. Such studies explain and confirm that living labs are coupled to other living labs by different means and have functions in innovation systems but also include many stakeholders in single living lab networks. In addition to that, this study underlines that, even though the literature on living labs identifies living labs as such types of networks, there are surprisingly few attempts to illustrate the network structures of living lab networks. As the framework of this study and when developing and concluding the framework in Chapter 4, this study applies such "perspectives", types and structures of living lab networks as a part of an innovation triangle of living labs (see Figure 7).

3.1.3 Actor, activity and resource perspectives

Living labs have multiple actors in networks. An actor–resources–activity model (ARA model, see e.g., Håkansson & Snehota, 2006) distinguishes between actors, resources and activities in networks. Numerous studies on living labs document actors, activities, and resources rather than employing *the ARA model*

per se to understand innovation in living lab networks. The present study considers the three perspectives as key elements to understanding innovation mechanism in living lab networks.

Actor perspective

The literature on living labs often distinguishes multiple *stakeholders in living labs* and underlines that living labs are grounded on *public–private partnerships (PPP, 3Ps)*[30] (cf. Niitamo et al., 2006; Feurstein et al., 2008; Arnkil et al., 2010; Lepik et al., 2010; Almirall & Wareham, 2011) or *public–private–people partnerships (PPPP, 4Ps)* (cf. Bergvalll-Kåreborn et al., 2009a[31]; Arnkil et al., 2010[32]; Ferrari et al., 2011; Molinari 2011; Westerlund & Leminen, 2011; Veeckman et al., 2013; Leminen & Westerlund, 2014). The former include citizens, firms and public authorities, who jointly create, prototype, validate and test services and technologies (Niitamo et al., 2006). The former, the *3Ps,* slightly differs from the latter, the *4Ps*, where firms, public agencies, universities, institutes, and users participate in innovation activities in living labs (Westerlund & Leminen, 2011). Existing living lab research typically examines main stakeholders, academia (universities and research centres), researchers, developers, industry, citizens, users, and public and private organisations in living lab networks (Ballon et al., 2005; De Ryuter & Pelgrim, 2007; Schuurman et al., 2011; Westerlund & Leminen, 2011). Prior studies propose stakeholders as '*providers*' including educational institutes, universities, researchers, developers or consultants bringing knowledge and promoting solutions for problems, '*users*' including end users, customers, or citizens to be studied or involved in innovation activities, and '*utilizers*' including a company or another organisation utilizing achieved results', and '*enablers*' including financiers or area/city development organisations enabling innovation activities in living labs (Leminen et al., 2012a). There are slight differences between a researcher and a developer: the former focuses on new knowledge production, whereas the latter offers development for end users.

[30] Arnkil et al. (2010) use the triple helix instead of 3Ps, and define the "*Triple Helix (TH) innovation model, academia (colleges, universities), government and industry constitute the three helices which collaborate with each other in order to create or discover new knowledge, technology, products and services, 23"*

[31] Bergvalll-Kåreborn et al. (2009a) label a public–private–people partnership (PPPP) as a business–citizens–government–academia partnership.

[32] Arnkil et al. (2010) include a broad variety of stakeholders as part of the quadruple helix model.

The literature provides versatile *archetypes of users*, *demographic users groups*, and *user typologies in living labs*. Such descriptions of different archetypes of users or demographic user groups include amateur users, children, elderly people, employees, hobbyists, professional users and students (cf. Lasher et al. 1991; Bengtson 1994; Hoving, 2003; Pierson et al., 2008; Arnkil et al., 2010; Vicini et al., 2012b; Leminen et al., 2012a; Luojus & Vilkki, 2013; Leminen et al., 2014b). Studies on living labs include everyday people who represent the end users' ordinary everyday experience and knowledge (Levén & Holmström, 2012). Lin et al. (2012b) characterise users by their participation including collective users[33], real-life users[34], and active users[35], in living labs. The authors explore user's participation with the help of their attitudes and practices as well as 'users' change in living labs and identify four archetypes of users: *approving passive*[36], *approving-exploring*[37], *doubtful-passive*[38], and *doubtful-exploring*[39]. Inspired by Dibben and Bartlett (2001)[40], Arnkil et al. (2010) identify three user perspectives: a user as a 'consumer', a user as 'collectivist' who participates in a decision-making process, and a user as a 'member of a community'. The authors couple users to perspectives of user involvement in the public sector. Schuurman et al. (2010b) take another perspective and classify different user typologies of prior innovation literature to understand users in living labs. The classification in grounded in both conventional closed innovation and open innovation

[33] Collective user refers multiple users in a community (Lin et al., 2012b).
[34] Real-life users refer to users recruited from a real-life environment (Lin et al., 2012b).
[35] Active user refers to an active participant rather than a respondent or a tested subject (Lin et al., 2012b).
[36] The approving-passive type refers to how users *"use the technology and they think this technology can help others to monitor their health situation in daily life (approving)… but their attitude is to wait for someone to help them to solve the problem" (Lin et al., 2012b, 238)*.
[37] The approving-exploring type refers to user that "*has a high level of identification with the product and thinks of ways to solve problems when encountering difficulties in operating the product"* (Lin et al., 2012b, 238).
[38] The doubtful-passive type refers to a user's "*doubts about the technology and being passive in performing the health checks, not to mention tackling difficulties"* (Lin et al., 2012b, 238).
[39] The doubtful-exploring type refers to a user that *"has a detailed understanding of the products, and despite having doubts about the effectiveness and future of the product, they are active in finding ways to improve it", (*Lin et al., 2012b, 238).
[40] Dibben and Bartlett (2001) propose a *consumerist approach* and a *collectivist approach* to public service user involvement. A consumerist approach sees a user consuming products and services, whereas a collectivist approach views users as a part of the decision-making process.

approaches including *the adaption-diffusion curve*[41] (Rogers, 2003), *use diffusion*[42] (Shih & Venkatesh, 2004), *lead users* (von Hippel, 1986), *pro-ams*[43] (Leadbeater & Miller, 2004) and *outlaws*[44] (Mollick, 2004; Flowers, 2008), and *bystanders*[45] (Ferneley & Light, 2006). In accordance with Kaulio (1998), Schuurman (2015) identifies three types of customer involvement: design for customers[46], design with customers[47] and design by customers[48].

Taken together, the actor perspective in living labs and studies on living labs share the view of multiple stakeholders. Living labs are grounded in *public–private partnerships (PPP, 3Ps)* or *public–private–people partnerships (PPPP, 4Ps)*. Studies on living labs often document *demographic user groups*, *archetypes of users*, and *user typologies* as a part of innovation activities in living labs rather than defining and explaining user roles per se in living labs. Such studies assume that users encompass a broad variety of users portrayed with their demographic characteristics and archetypes rather than slotting them into any single predetermined form of a user. User and stakeholder roles will be discussed in Chapter 3.2: Roles in innovation networks.

Activity perspective

The activity perspective is perhaps one of the most used perspective for describing living labs as networks. The majority of studies explain or at least identify types of activities conducted in living labs. The first stream of living lab

[41] The adaption-diffusion curve approaches assume that user roles differ in a diffusion curve, whereas users are categorized, as innovators, early adopters, early majority, late majority and laggards, based on speed of adaptions (Rogers, 2003).
[42] The *use diffusion* refers to variety of use and rate of use, whereas the users groups are intense users, specialized users, nonspecialized users, and limited users.
[43] Leadbeater and Miller (2004, 9) identify *pro-ams* and refer to them as "*innovative, committed and networked amateurs working to professional standards*".
[44] Mollick (2004, 19) depicts *outlaws* as "*an underground, pirate, parasitic community*".
[45] The *bystander* refers to passive users not intending to react or respond to development activities (Ferneley & Light, 2006).
[46] Kaulio (1998) proposes three types of customers´ involvement: design for customers, design with customers and design by customers, as described by Eason (1992). Design for customers approach denotes that the customers' role is to reveal their behaviour or knowledge for product development (Kaulio, 1998).
[47] The design with customers approach focuses both on understanding customer preferences, needs and requirements as well as reacting to or validating different design solutions (Kaulio, 1998).
[48] The design by customers approach expresses that customers actively participate in design activities (Kaulio, 1998).

studies typically describes user activities in a broad variety of real-life environments. The second stream of living lab studies often incorporates activities as a part of an iterative and phased approach. Such studies provide numerous illustrations of activities in phases or activities in living labs including the set-up of a living lab (Kang, 2012; Lin et al., 2012b), the management of different phases in living labs (Gong et al., 2012), and various activities in different phases of living labs (Shampsi, 2008: Ferrari et al., 2011; Chen, 2012; Lin et al, 2012a; Bendavid & Cassivi, 2012; Katzy et al., 2012). The phases often start from an early development phase and end up near market activities such as a market launch (Lin et al., 2012a; Vicini et al., 2012a; Cleland et al., 2012).

In turn, the third research stream on living lab studies typically explains activities beyond the two prior streams by intertwining activities and other conceptualisations. Among them, such studies identify two alternative organisational activities in living labs: exploration and exploitation. For example, Almirall and Wareham (2011) emphasise that living labs focus both on exploration and exploitation. Leminen and Westerlund (2014) provide one of the rare explicit usages of ambidexterity. The authors link exploration, exploitation and ambidexterity to innovation strategies of living labs. Organisations pursue divergent innovation strategies. Schuurman et al. (2013) in turn include retention[49] as the third crucial conceptualisation with exploration and exploitation in living labs.

Many different definitions of living labs implicitly embed ambidexterity, including both exploration and exploitation activities such as creating, prototyping, validating and testing, (cf. Pierson & Lievens, 2005; Niitamo et al., 2006; Westerlund & Leminen et al., 2011). Ballon et al. (2005) claim that living labs covers both design and testing activities. Hence, living labs locate in the middle of the polarised scale of design and testing (Figure 5). They distinguish living labs from other types of test and experimentation platforms by their conducted activities and the maturity of technologies. The authors (2005, 1) also include "*all facilities and environments for joint innovation including testing, prototyping and confronting technology with usage situations*" for their definitions of test platforms.

[49] Retention refers to incorporating knowledge into the internal knowledge base or interfirm relationships represent the external knowledge base (Lichtenthaler & Lichtenthaler, 2009).

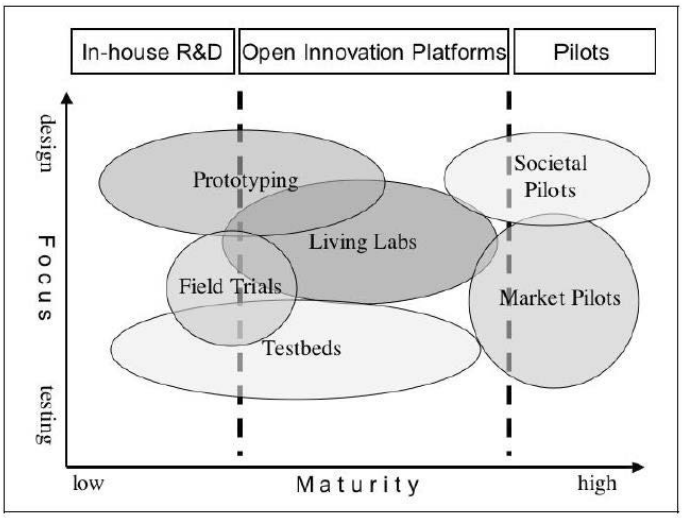

Figure 6. Conceptual framework of test and experimentation platforms (Ballon et al., 2005, 3)

Living labs often cover a wide range of activities (Bendavid & Cassivi, 2012) and different approaches to user involvement (Westerlund & Leminen, 2011). For example, Ballon et al. (2005) propose a user as being both an object and a subject in innovation development activities. Being an object in innovation development activities includes opening user needs and experiences (Schuurman et al., 2011) and validating and testing products, services, technology and systems (Lasher et al., 1991). Being a subject refers to co-developing or co-creating innovation (Leminen, 2011) in living labs. *A user as an object* is closely related to a customer-centric model, and *a user as a subject* is closely related to a user-driven model (Leminen, 2011). Følstad (2008a) claims that different types of living labs support user-centered design and user-driven innovation. Such perspectives have been documented to bring value for organisations utilizing the innovation modes. Hence, user-centered activities are often associated with testing and validating, whereas user-driven activities represent activities beyond that including activities such as developing and co-creating. Hence, the user-centered and user-driven perspectives are associated with their activities.

Many studies on living labs incorporate and extend activities of 'prototyping' (Abowd et al., 2000; Ras et al., 2007; de Louw & Dörflinger, 2010; Johansson &

Lundh Snis, 2011; Tang & Hämäläinen, 2012), 'field trials' (de Louw & Dörflinger, 2010), 'testing' (Zhong & Coyle, 2006; Bergvall-Kåreborn, 2008; Kipp & Schellhammer, 2008; Ferrari et al., 2011), 'societal pilot' (Mutanga et al., 2011) and 'market pilot' (Bliek et al., 2010; Ferrari et al., 2011) as a part of living lab activities. Among the activities, Almirall and Wareham (2008) emphasise user involvement and experimentation with all stakeholders as key activities in living labs. Juujärvi and Pesso (2013) include diverse activities originated by stakeholders, that is enablers, utilizers, providers and users, in a context of urban living labs.

Living lab networks include such actors, but there are some scattered studies that identify management and orchestration within a living lab network. For example, Almirall and Wareham (2008b) propose that organizing and structuring user participation fosters co-development in living labs. Extant studies reveal differences in activities to organise, coordinate, and manage. Many studies include the bottom-up approach, which is grounded on emergent, grassroots ideas that are collectively developed for mutually shared objectives, and the opposite approach, a top-down approach, relies on activities to direct and manage (cf. Lievens et al., 2011; Westerlund & Leminen, 2011; Leminen et al., 2012a; Sauer, 2013). The previously proposed types of living lab networks are ground on organizing activities and structures differently during research and development collaboration by the driving stakeholder (Leminen et al., 2012a). The authors suggest that the "driving actor", the most prominent actor, makes a crucial impact on the benefits for stakeholders.

To sum up an activity perspective in living labs, this study includes a broad variety of activities as a part of the 'layered' research streams to understand living labs and particularly living lab networks. This study underlines and shares the view with the extant studies of living labs that living labs cover both exploration, exploitation, and retention including a broad variety of activities such as creation, development, validation and testing activities in living labs. Therefore, this study underlines that a plurality of such activities in living labs are associated with different network structures.

Resource perspective

The underlying assumption of a living lab encompasses multiple and different stakeholders that bring, share, and develop diverse knowledge and resources for the usage of living labs and their stakeholders. This study refers to a resource perspective of living labs, where all tangible and intangible resources, information and knowledge are provided, shared, developed, learned and accumulated by stakeholders. Guzmán et al. (2013) suggest some needed resources in living labs such as virtual environments, physical places, physical resources and software tools. The present study identifies two streams of resource perspectives in extant studies on living labs and labels the streams as: (i) *collaborations enhance and strengthen the emergence of knowledge and resources,* and (ii) *conflicts are a source of new knowledge and resources*. Both streams underline and assume that collaborations take place between stakeholders; thus, they learn, share, and accumulate knowledge and resources in living labs.

Collaborations enhance and strengthen the emergence of knowledge and resources

A former stream underlines collaboration and mutual, beneficial relationships between stakeholders in living labs. For example, Turgut and Katzy (2012) propose that network collaboration opens up discussion on which stakeholders coordinate or manage living lab activities. Van der Welt et al. (2009) suggest that collaboration, knowledge sharing and experimenting are fuels for living labs. Dekkers (2011) emphasises that a resource-based view characterises collaboration and learning between stakeholders in living lab networks. Levén and Holmström (2008) address a need to integrate heterogeneous stakeholders and their goals. Molinari (2011) in turn proposes that stakeholders interact to pursue decision making towards collective actions and goal. A living lab and its stakeholders often have both mutually shared and individual interests, but sometimes their interests are partly conflicting (Bendavid & Cassivi, 2012). This study underlines that mutual and beneficial relationships in a living lab network support collaboration and sharing of tangible and intangible resources and knowledge. In contrast, living labs rarely have the power to control their stakeholders; rather, the mechanism is to influence their stakeholders. Therefore, it is crucial to include expertise and resources of all stakeholders and support

collaboration and learning to reach the benefits living labs may bring. Typically, relationships between stakeholders are collaborative; thus, each and every stakeholder has shared its own interests in living labs (Westerlund & Leminen, 2011). Hakkarainen and Hyysalo (2013) emphasise that the handling of tensions and conflicts leads to deeper collaboration and learning between stakeholders in living labs, when the authors analyse a process of learning, tensions and conflicts between the actors in living labs. The finding of Hakkarainen and Hyysalo (2013) is in line with the conventional management literature, which pursues to reduce conflicts and tensions by providing different management tools and practices for reducing or avoiding unspecified events or disturbances in innovation activities

Conflicts are a source of new knowledge and resources

In contrast to the former stream of the resource perspective, the latter stream underlines that living labs foster the collision of products and services in real-life situations rather than reducing conflicts per se (Leminen & Westerlund, 2013). The authors find that tensions and conflicts take place during the 'usage of products and services in real-life situations' rather than existing between stakeholders in living labs. In this vein, surprisingly few studies have so far identified the collision paradox in open innovation networks and particularly in the literature on living labs (Leminen & Westerlund, 2013). The authors claim that the multitude of real-life environments and the multitude of different types of users in living labs speed up the innovation, thereby pursuing collisions of products and services in living labs (i.e., stressing particular user behaviours or unwanted characteristics of a product and a service).

To sum up the resource perspective, this study identifies two partly overlapping streams: *collaborations enhance and strengthen the emergence of knowledge and resources,* and *conflicts are source of new knowledge and resources*. This study underlines that both streams share the view that multiple different stakeholders provide, share, develop, learn and accumulate their diverse tangible and intangible knowledge and resources for the benefit of living labs and their stakeholders. The streams differentiate the ways conflicts and tensions are managed. The former stream assumes to avoid them between stakeholders whereas the latter stream encourages collisions of a product and a service in a real-life situation rather than reducing conflicts per se. This study shares the view of the latter stream. Chapter 3.3.2 continues by describing knowledge and

resources by innovation outcomes, particularly tangible and intangible innovations in living labs.

In examining the living lab as a network, studies on living labs include *types of living lab networks,* and *activity, actor, and resources perspectives* in living labs networks, and they employ innovation practices grounded on open innovation principles. Extant studies on living lab networks depict relationships between stakeholders in living labs in networks rather than *living lab network structures*. However, the literature on networks employs a well-adapted categorisation of network structures suggested by Barabasi (2002) including *centralised, decentralised,* and *distributed* network structures. To conclude living labs as networks, the present study applies such "perspectives", types of living lab networks, activity, actor, and resources perspectives, and networks structures, as a part of an innovation triangle of living labs (see Figure 7). This innovation triangle forms the framework of this study when developing and concluding the framework in Chapter 4.

3.2 Roles in living lab networks

This subchapter first presents four different approaches to the role theory including *structural*, *symbolic interactionist*, *resource-based* and *action-based* approaches. Next, the chapter depicts roles and their dynamics in innovation networks. Finally, the chapter reveals extant studies on user and stakeholder roles in living labs.

3.2.1 Roles in innovation networks

The social sciences literature widely distinguishes actor roles[50] through the role theory and multiple other approaches to understand roles (e.g., Linton, 1936; Biddle and Thomas, 1966; Broderick, 1999; Tuominen, 2013). Conventionally, the role theory focuses on individuals, whereas this study covers organisations in innovation networks as key actors as suggested by Heikkinen et al. (2007). In role theory, Nyström et al. (2014) distinguish four approaches: *structural*, *symbolic interactionist*, *resource-based* and *action-based* approaches. The *structural approach* is grounded on an assumption that an organisation adopts a predefined social structure and executes role(s) related to it. According to Havila (1996), a

[50] This study refers to a role as the expected behaviours of parties in particular positions (cf. Allen & van de Vliert, 1984).

position detects an actor in a structure or in a system such as an innovation network. An actor´s position determines a possible role in a network; thus, an actor reaches a pre-established position in the network to fulfil the role for the position (Baker & Faulkner, 1991). Early industrial network studies often take this perspective to examine roles because sets of norms assign firms behaviour and position in the business network (Mattsson, 1985). Further, firms locate themselves in the network with help of a position (Håkansson, 1987; Havila, 1996). The *symbolic interactionist* approach assumes that a social structure position does not predefine a role, rather a role is postulated when determining positions (Callero, 1994). A change of a role converts a position in a network (Anderson et al., 1998; Ashforth, 2000). In this vein, industrial network studies often presume that positions can be affected by roles (cf. Heikkinen et al., 2007). Therefore, network actors increasingly form their business and operating environment.

The third approach, the *resource-based approach,* has a two-fold character for resources to call for membership and acceptance in a social community (Baker & Faulkner, 1991) and to ingress to social, cultural, and material capital for pursuing actors' interests. Similar to the symbolic interactionism approach, roles may be adjusted in positions rather than a position leads to a role. Baker and Faulkner (1991) analyse used roles in new positions and social structure creation in innovation networks. Therefore, "roles as resources", as introduced by Baker and Faulkner (1991), may be used as a tool to steer resources and establish social structures (Callero, 1994). The structuralist, symbolic interactionist, and resource-based approaches to roles are ground in constructivist views, and such approaches typify and clarify what happens to roles (cf. Weick, 1995). The perspectives of the four approaches enable the examination of actions and reactions in living labs.

The prior literature identifies innovator roles and role tasks and suggests actions to be taken or roles to be played for innovation in a normative approach to roles (Gemünden et al., 2007; Heikkinen et al., 2007). The present study proposes a new and fourth perspective on stakeholder roles, on that is more specifically the '*action-based approach*' to role theory. The action-based approach refers to the actions and reactions determined by other actors, in which role tasks are linked to conducted activities as well as accessed and used physical and human resources when targeting goals. The action-based approach differs from the

structuralist, symbolic interactionist, and resource-based approaches both in its epistemological assumptions and how roles are construed. The action-based approach implies that roles and innovations emerge when products, services, technologies and systems are validated, developed and created in living labs. Such an approach integrates both open and user-centred innovations, where users generate new products and services and companies form new partners (Chesbrough & Appleyard, 2007; Corsaro et al., 2012).

Each of the four role approaches underlines the importance of roles, where perceptions and interpretations of role approaches vary according to role. The *structuralist approach* is grounded on predetermined roles in role behaviour. The *symbolic interactionist approach* suggests a role as being created in a social structure. The *resource-based approach* views roles as a resource to create position, thus roles are linked to positions. *The action-based approach* is grounded on assumptions that the chosen role is based on activities or tasks to be conducted in the network, and considers a role in a development process.

The role approaches propose two concepts, role-taking and role-making, which are inherited from the social sciences, whereas a set of descriptions steer position holder behaviour in role theory (cf. Biddle & Thomas, 1966; Turner, 1988; Herrmann et al., 2004). Role-taking is grounded in joint expectations for a role and interprets the behaviour of other actors to create the role. Other actors may or may not accept the taken role (Turner, 1988). In contrast, role-making refers expectations to concrete behaviour. Role-making is grounded on assumptions to "make" a role for individuals (cf. Biddle & Thomas, 1966; Turner, 1988; Herrmann et al., 2004). In the context of an innovation network, actors either engage in role-making, by creating a role for themselves, thereby altering the structure of the innovation network, or they engage in role-taking, by acting within a limited, predefined structure and assuming an existing role.

Role mechanisms refer the development of roles and their subsequent patterns (Herrmann et al., 2004). More specifically, the role mechanism includes role ambiguity[51], (Kahn et al., 1964), role assignment[52], role change[53] (Herrmann et

[51] According to Kahn et al. (1964), role ambiguity refers to a condition being difficult to react and accomplish the role expectations or demands.
[52] Role assignment refers to a role to be taken or rejected (Herrmann et al., 2004).
[53] Role change describes when an actor gives up a role and takes on a new one (Herrmann et al., 2004).

al., 2004), inter-role conflict[54] (Rizzo et al., 1970), role definition[55] (Levinson, 1959; Herrmann et al., 2004), and role transition[56], role alteration[57], and role distance[58] (Allen & van de Vliert, 1984). These role concepts are ways to understand role-taking or role-making.

The four approaches to role theory provide different views of roles in innovation networks, as shown in Table 5. The structuralist approach proposes that a role is given to an actor and is predetermined by other actors, and the given role is performed in the network. The remaining three approaches to roles vary according to the roles and role-related tasks. The symbolic interactionist approach views a role as being created in a social structure, such as a network, whereas the resource-based view uses a role as a resource, to control resources or establish structure. Conversely, the action-based approach proposes that a role is determined by actions and is based on openness and the common goals of the network. The literature on role theory chooses relevant approach(es) to roles depending on their assumptions. These in turn reflect into the situation and goals in an innovation network.

Table 5. Four approaches to role theory (Nyström et al., 2014, 486)

Approach to role	Use of role in network	Mechanisms
Structuralist	Role is predetermined by the actors in a network	Role-taking
Symbolic interactionist	Role is created in a social structure, such as the network	Role-taking Role-making
Resource-based	Role is used as a resource to, e.g., control resources or establish structure	Role-taking Role-making
Action-based	Role is determined by actions and based on openness and common goals of the network	Role-making

[54] Inter-role conflict refers to a conflict between roles, if an actor has or takes multiple roles (Herrmann et al., 2004).
[55] Role definition refers to tasks to be modified because of the dynamic between existing roles (Herrmann et al., 2004).
[56] Role transition refers to *"the process of changing from one set of expected positional behaviors in a social system to another.", (*Allen & van de Vliert, 1984, 3)
[57] Role alteration refers to *"temporary changes in role relationships whereas a more permanent shift from one position to another is called role transition." (*Nyström, 2008, 94*)*
[58] Role distance refers to *"the efforts taken in order to differentiate the self from the role."* (Nyström, 2008, 94)

Taken together, this study applies all four approaches to roles by explaining innovations in living labs, where roles include both the means to innovate and the organisation of innovation by actors in networks.

3.2.2 Roles and dynamics in innovation networks

Previous research addresses various important innovator roles. These roles are incorporated with innovation activities between and within organisations and have often associated with impacts on innovation. These innovator roles includes '*gatekeepers*' (Allen, 1970; Tushman & Katz, 1980), '*champions'* (Schon, 1963; Howell & Higgins 1990a, 1990b; Markham, 1998), and '*expert-', 'power-', 'process-*', or '*relationship promoters'* (Gemünden, 1985; Gemünden & Walter, 1998; Walter & Gemünden, 2000; Herrmann et al., 2006; Gemünden et al., 2007). Such role descriptions are mainly on the individual level. The gatekeeper role includes activities such as required information filtering and dissemination, information and communication exchange, assembling information from various sources and networking (Allen, 1970). The champion is often linked to the success or failure of innovations. Gemünden et al. (2007, 409) distinguish four promoter roles, which influence innovation success as follows. The power promoter has the hierarchical power to steer a project, provide resources, and help to prevent forthcoming obstacles. The expert promoter conveys needed technological knowledge in an innovation process. The process promoter relies on diplomatic skills to integrate the power promoter and expert promoter in an innovation process. The relationship promoter in turn uses strong personal ties to both internal and external actors. Galbraith (1999) proposes three innovator roles in innovation networks: an '*idea champion'* conceives creative ideas, a '*sponsor*' identifies the value or usefulness of the idea, and a *'leader'* is a central player for communication. Meyer (2000) labels a '*devil's advocate'* as individuals who deliberately disagree with or criticise innovation. Previous research on innovator roles merely analysed roles on an individual actor level rather than roles representing the level of organisational participants being analysed on a collective level. For example, Tuominen (2013) documents individual- and collective-level roles in innovation and the development of activities in professional service firms.

Heikkinen et al. (2007, 918-920) offer perhaps one of the most comprehensive

descriptions about stakeholder roles in innovation networks, including network and task levels. The authors described roles at both a collective level and an individual level. They identified and depicted twelve actor roles in innovation networks (see Table 6). Heikkinen et al. (2007) propose that actors perform several roles rather than a single role, whereas conducted activities determine actors' roles in a network.

Table 6. Roles in living labs network (Heikkinen et al., 2007, 917-920)

Roles in innovation network	Characteristics
1. Webber	Initiates network connections by deciding which actors are to be contacted to accomplish the development process.
2. Instigator	Influences by encouraging other actors in their decision-making processes.
3.Gatekeeper	Has significant resources and key elements, and has power to determine the usage of these for other actors and activities in an innovation network.
4. Advocate	Has a background role and does not interfere with operations but distributes positive information and offers connections to an innovation network.
5. Producer	Plays a significant role by contributing concrete development and realisation activities.
6. Planner	Injects input and intangible resources into a development process.
7. Entrant	Intervenes in the ongoing development process to protect its own rights.
8. Auxiliary	Plays an active role that strengthens towards the end of development activities.
9. Compromiser	Attempts to avoid contradictions or conflicts by balancing actions and relationships in an innovation network.
10. Facilitator	Furnishes an innovation network with resources, such as venues, without intervening in the process itself.
11. An aspirant	Plays the role of an 'outsider' who aims to participate in development activities.
12. Accessory provider	Attempts to promote and demonstrate its product and service portfolio and expertise in development activities.

Taken together, the bulk of the literature on actor roles and dynamics in innovation networks is grounded in a conventional, closed, company-led innovation paradigm, rather than open innovation or customer innovation research philosophies (Leminen et al., 2015b). In other words, suggested roles are grounded on assumptions of collaborations between companies in innovation networks. Open innovation networks, and particularly living lab networks, in

turn assume opening innovation with a diverse and broad variety of stakeholders and particularly users and user communities, which reflect the roles and dynamics in living lab networks.

3.2.3 Roles and dynamics in living lab networks

In contrast to stakeholders, archetypes of users, demographic users groups, and user typologies, in extant studies on *user roles in living labs* are rare and scattered. This study distinguishes a stakeholder and an actor from its role(s), where stakeholders include a variety of actors, such as users, citizens, public organisations, academia, research organisations and firms, involved as a part of living lab activities. This study defines a role as an expected behaviour of a stakeholder or an actor in a particular position rather than referring to a stakeholder or an actor itself, or their archetypes, demographic groups, and typologies.

Extant studies on living labs are ambiguous as to whether a stakeholder represents an individual in an organisation or an individual represents an organisation. This study emphasises that stakeholders represent their organisations or community; thus, a role represents the collective role of the actor in living labs. Among studies on user roles in living labs, Hoving (2003) proposes that users are *co-producers* of innovations. She notes that researchers operate within living labs and therefore are able to both monitor "*from the inside" and "intervene in order to contribute to a better implementation of technological innovations*" (Hoving (2003, 4). Even Hoving (2003) labels users as co-producers, but does not clearly explain the role. Thus, her study does not define the user role or explain the activities users are involved in. Similar to Hoving (2003), Ballon et al. (2005) identify users as co-producers in living labs, where users interact and exchange views with developers in living labs. Boronowsky et al. (2006a) and Vérilhac (2011) propose that users act as co-developers, when technologies are developed in relation to social contexts and needs. CoreLabs (2007) in turn proposes that users may take different user roles, and their study labels the roles as *contributors* and *co-creators* in innovation activities. The living lab roadmap study (CoreLabs, 2007) incorporates users (people, users and buyers) who take active roles in the research, development and innovation process.

Vérilhac (2011) proposes *test users* as an additional role, where users test innovative products, services and business models. Tang et al. (2012) in turn suggest that users may act as end users (consumers), testers, and co-creators of services; thus, users have multiple roles. However, the authors are ambiguous when defining and explaining user roles. The authors mentioned such roles and explained user activities rather than linking such activities to the proposed user roles. Sauer (2013) suggests three user roles including *designers*, *testers,* and *co-creators* in living labs. Similar to the other prior studies, she is ambiguous in her definition of the specific user roles. The author couples many living lab activities to user roles but fails to clearly offer explicit definitions for them. The present study interprets her three user roles as follows. In the first user role, a designer refers to a user that learns with a specific design problem by creating, developing, and prototyping technological artefacts. A tester refers to a user that tests, implements and validates technologies but also monitors people acting with the technologies. The last user role, a co-creator, creates something new, such as a product or service, together with other participants and is equal to other stakeholders. This study views that the roles suggested by Sauer (2013) are similar to the prior suggested roles.

Taken together, extant studies on user roles are rare and scattered, and such user roles are inadequately defined in studies on living labs. The present study suggests that many of the identified user roles are similar. This study merges the user roles of 'contributor', 'co-producer', 'co-developer', and 'designer' and labels them as a 'contributor' user role. This study also merges 'test user' and 'tester', and labels them as a 'tester' user role. To sum up, prior studies on living labs identify three user roles: tester, contributor and co-creator.

Some scattered descriptions of the other *stakeholder roles* exist in the literature on living labs. Prior studies on stakeholder roles are ambiguous in explaining stakeholder roles. This study underlines that such prior studies describe stakeholders rather than their roles. Similar to user roles, studies on living labs are ambiguous in explaining stakeholder roles. For example, Hoving (2003) describes a researcher (a stakeholder) as an actor rather than a role, where the researcher monitors innovation activities and seldom intervenes in the activities to contribute better implementation in social practices. Similarly, Kipp and Schellhammer (2008) and Arnkil et al. (2010) mainly document various stakeholders rather than explaining their roles in living labs. In addition, Kipp

and Schellhammer (2008) identify the roles *initiator* and *mediator*. The former role identifies needed actors in living labs. This role is similar to a previously identified role of a webber by Heikkinen et al. (2007). The latter role aligns interests and smooths the collaboration in living labs. Ebbesson and Svensson (2012, 2013) propose that a researcher acts as a *facilitator* when co-creating services and balancing innovation activities. The role of facilitator is a similar role as described earlier by Heikkinen et al. (2007). Ebbesson and Svensson (2013) include the additional role of the researcher as a *manager* in living labs. The authors are ambiguous in explaining the manager role. However, the present study interprets that the role includes many activities and distinct stakeholder roles of innovation networks as documented by Heikkinen et al. (2013). When comparing the roles to the extant classification of stakeholder roles in innovation networks by Heikkinen et al. (2007), one new stakeholder role, the *mediator,* emerges in living labs.

Prior literature on living labs explains multiple activities of stakeholders rather than having multiple roles or their dynamics and patterns. Studies on living labs assume that stakeholders are coupled to multiple activities and that the same stakeholder may pursue multiple activities. For example, Arnkil et al. (2010) claim that the same stakeholder can pursue multiple activities rather than just a single one. Kusiak (2007) proposes that a living lab approach relies on the multi-role and multi-faceted involvement of a customer. Similar to Arnkil et al. (2010), Kusiak (2007) refers to activities rather than roles. Thus, customers are a part of multiple and subsequent activities including offering innovative ideas, validating design, and having dialogue with a 'producer' rather than having multiple roles. Almirall and Wareham (2009) broadens this view by proposing that users may play the 'dual role' of provider in a living lab, where the authors explain that users may simultaneously be a source of innovation and an 'innovation enabler. ' The authors are ambiguous in explaining the dual role of the user; rather, they refer to the simultaneous multiple activities of user. This study perceives the dual role of users, where users may simultaneously act as source of innovation and transform the needs of users into real products or services.

To sum up, extant studies on roles in living lab networks, particularly with respect to user and stakeholder roles, often explain the various stakeholders, and particularly users, in living labs and couple them to living labs activities (please see the actor and activity perspective in Chapter 3.1.3) rather than explicitly

introducing and defining user and stakeholder roles. This study claims that the extant literature on living labs provides some scattered studies of user and stakeholder roles, but that they are inadequately defined. More specifically, this study encompasses the identified user and stakeholder roles to understand and document innovation practices grounded on open innovation principles. The literature on living labs include three user roles: a *tester*, a *contributor*, and a *co-creator*, and one stakeholder role: a *mediator*, and twelve roles suggested in innovation networks including a *webber*, an *instigator,* a *gatekeeper*, an *advocate,* a *producer*, a *planner,* an *entrant*, an *auxiliary, a compromiser*, a *facilitator*, an *aspirant*, and *an accessory provider*. Studies on living labs propose that stakeholders may pursue and undertake multiple simultaneous activities rather than multiple roles. This study underlines that, although the extant studies on innovation networks describe stakeholder roles in innovation networks, user and stakeholder roles and their role dynamics are poorly understood in living labs. More specifically, this study underlines the extant research gap on user and stakeholder roles and their dynamics in living labs, where the literature on living labs deserves more research on understanding user and stakeholder roles and their dynamics. To conclude the discussion of stakeholder and user roles, this study applies such "perspectives", stakeholder and user roles, as a part of an innovation triangle of living labs as the framework of this study when developing and concluding the framework in Chapter 4 (see Figure 7). Next, this study discusses innovation outcomes in living labs.

3.3 Innovations in living labs

First, this subchapter gives a brief introduction to innovations and types of innovations. Next, it examines the literature on innovation outcomes in living labs, which include tangible and intangible innovations such as products, services, and systems, information, knowledge, and practices and different types of innovations such as incremental and radical innovations.

3.3.1 Innovation outcomes

The extant literature provides a broad range of innovation definitions. Gopalakrishnan and Damanpour (1994) claim that scholars view innovations either as discrete artefacts (product or outcome) or as a process for creating something new. Van de Ven (1986) includes new ideas, people, transactions, and

institutional context into a definition of innovation. Newness or novelty widely distinguishes innovations (Slappendel, 1996). Garcia and Calantone (2002) propose that innovativeness or the degree of newness of innovations varies in many studies, and it has been operationalised between "new to the world" and "new to a consumer". Further, it is not always clear from "whose perspective the degree of newness is viewed and what is new" (Garcia and Calantone, 2002, 112). The main body of studies claims that the literature suggests different views in defining innovations (cf. Garcia & Calantone, 2002; Baregheh et al., 2008; Edwards-Schachter et al., 2012). For example, Abernathy and Clark (1985) document market niche, regular, revolutionary, and architectural innovations. They incorporate the varied role of innovations in different competitive environments in the automotive industry. Henderson and Clark (1990) claim that incremental and radical innovations are incomplete and do not explicate minor improvements in technology products. The authors include modular and architectural innovations beside incremental and radical innovations when analysing technological change in the semiconductor equipment industry. Tushman et al. (1997) elaborate innovation streams in IT industries, where a broad variety of innovations including incremental, product, service or process, major process, major product or service, generational, and architectural innovations are distinguished from underlying technology cycles. Chandy and Tellis (1998) in turn study product innovations in three high-tech industries and found incremental, technological breakthrough, radical, and market breakthrough innovations. Many attempts exist to differentiate product and service innovations (cf. Avlonitis et al., 2001; Paswan et al., 2009). A premise of such studies underlines that products and services are different. Morrar (2014) takes a broader perspective on service innovations. The author describes service innovation by the assimilation[59], demarcation[60] and integration[61] approaches. In accordance with Morrar (2014), the present study takes the integrative approach for understanding innovations.

[59] The assimilation approach claims that product and service innovations are similar, particularly technological innovations.
[60] The demarcation approach seeks characteristics to differentiate service innovations, particularly non-technological innovations.
[61] The integration approach aggregates two prior approaches and claims that there is a convergence of products and services. This implicates that products and services are becoming similar to each other.

Van de Ven (1986, 590) defines an innovation as "*the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order*." Baregheh et al. (2008) attempt to pool innovation definitions from different disciplinary literature and suggest six attributes to characterise innovation definitions including type of innovation, nature of innovation, means of innovating, innovation and people, stages of innovation and the aim of innovation. The authors define innovation as "*the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace, 1334*". Such a definition explicitly includes commercial organizations rather than incorporating all stakeholders or benefits as suggested in many definitions on social innovations (cf. Goldenberg et al., 2009). For example, Murray et al. (2010, 3) define social innovations as "*new ideas (products, services and models) that simultaneously meet social needs and create new social relationships or collaborations"*. In accordance with the prior complementary definitions of innovations, this study attempts to redefine innovations by incorporating an innovation as a market, technology and social newness of ideas including products, services, systems, models and prototypes, where commercial and other organisations differentiate ideas to meet market or social needs in marketplace(s) or social arena(s) to create new or improved value, social relationships or collaborations for a broad variety of stakeholders, particularly in innovation networks.

Garcia and Calantone (2002) provide an extensive literature review of various types and levels of innovations, in which they argue that a plurality of innovation typologies results in partly overlapping classifications. More specifically, the authors claim that different types of innovations are categorised under different typologies. Further, there lacks consensus between different categorisations for innovations because innovation classifications are often anchored into contexts and other organisational dimensions including strategy, size, and performance (cf. Ettlie et al., 1984; Camisòn-Zornoza et al., 2004; Jansen et al., 2006; Oke, 2007; Paswan et al., 2009; McDermott & Parjago, 2012). Given the lack of consensus of innovation classifications, the present study applies perhaps the most accepted innovation classification including products, services, and systems into incremental and radical innovations (Dewar & Dutton, 1986; Johnson et al., 2000; Paswan et al., 2009).

The majority of innovations can be classified as incremental; radical innovations are rare (Garcia & Calantone, 2002). However, Dewar and Dutton (1986) underline that it is hard to distinct radical and incremental innovations. They label the difference between radical and incremental innovations by the degree of novelty and new knowledge in innovations. Incremental innovations lack a degree of novelty (Oslo Manual, 2004; Popadiuk & Choo, 2006). Dewar and Dutton (1986) in turn propose that "novelty" is likely to change and is a perception over the time. According to McDermott and O'Connor (2002), incremental innovations differ from radical innovations given that uncertainties in markets and technologies often characterise radical innovations. Radical innovations include extreme, long-term changes in marketing or technology discontinuities (Garcia & Calantone, 2002). Incremental innovations include incremental, minor changes in products, services, processes or marketing and technology continuity, which echo current customer and market needs (Dannels, 2002; Garcia & Calantone, 2002; Benner & Tushman, 2003; Oslo Manual 2004). Further, incremental innovations are exploitative innovations whereas radical innovations are explorative (Benner & Tushman, 2003; Jansen et al., 2006). Raisch et al. (2009) argue that the exploitation and exploration approach is needed in innovation development. Radical innovations reduce the relevance of existing resources, skills and knowledge thus creating new markets (Abernathy & Clark, 1985). In this vein, Popadiuk and Choo (2006) classify innovations from knowledge perspectives. The authors propose that radical innovations often appear unexpectedly, whereas incremental innovations represent relatively minor changes and thus do not include a high degree of novelty. Incremental innovations often lean on formal processes and clearly defined roles; in contrast, radical innovations are grounded on more informal processes and a willingness to experiment (Von Stamm, 2003). Benner and Tushman (2003) claim that formal process-management practices reduce radical innovations. Innovation experiences and access to information are often associated with radical innovations (McDermott & O'Connor, 2002; Sheremata, 2000).

Radical and incremental innovations have been suggested to differ by strategy, organisational structure, and processes (Ettlie et al., 1984; Cesaroni et al., 2005). The literature is inconsistent on the relationship between size and innovation (cf.

Camisòn-Zornoza et al., 2004; McDermott & O'Connor, 2002).[62] The contradictory results between the size of a company and innovation outcome allude to other factors that may flatten innovation outcomes. For example, innovation literature typically focuses on incremental innovations and their management mechanisms in contrast to radical innovations (cf. Ettlie et al., 1984; Dewar & Dutton, 1986; McDermott & O'Connor, 2002). Dewar and Dutton (1986) in turn propose that knowledge resources are more important for radical innovations than incremental innovations. Further, Sheremata (2000) concludes that radical innovations require balancing structures and processes to gain new ideas, knowledge and information and integrate them into collective action. Last, Carcia and Calantone (2002) argue that radical innovations cannot be organised but their emergence may be fostered through the creativity and genius of innovators.

To sum up, this study shares the view of extant studies on incremental and radical innovations that innovation mechanisms are supported by different means including knowledge resources and structures. Particularly innovation mechanisms of radical innovations cannot be 'strictly' organised; rather, they may be fostered to support the emergence of such innovations. Studies on innovation suggest different means of categorising innovations. In accordance with other studies, particularly those on social innovations, this study encompasses both types of innovation and tangible and intangible outcomes for understanding outputs in living labs and includes different types of innovations such as radical and incremental innovations. Next, innovation outcomes in living labs are discussed, including types of innovations and tangible and intangible innovations.

[62] Bigger companies have better abilities to create and employ technological knowledge and capabilities for radical innovations (McDermott & Prajogo, 2012). In other words, there is a positive relationship between innovations and the size of companies because large companies have access to greater resources. Radical product innovations directly link to the performance of organization(s) (Chandy & Tellis, 1998). Camisòn-Zornoza et al. (2004) and McDermott and O'Connor (2002) take a contradictory view and document a negative relationship between size and innovation, where large companies may be more bureaucratic and unwilling to react and take risks. Exploitation, exploration, ambidextrous innovations are intertwined with the performance of an organization in small and medium-sized enterprises (SMEs) (McDermott & Prajago, 2012).

3.3.2 Innovation outcomes in living labs

Innovation is often used as a buzz word in research on living labs, where studies on innovations include *tangible innovations* such as products, services, and systems, *intangible innovations* such as knowledge, information, and practices and different *types of innovations* such as incremental and radical innovations.

By definition, living labs aim to create, prototype, validate and test new technologies, products, services and systems in real-life contexts. Living labs assume that outcomes are the results of innovation activities, where they highlight actors, activities and resource perspectives in living labs. Studies on living labs provide some attempts to classify outcomes, where they depict products, services, solutions or systems to be developed, validated or tested (cf. Lasher et al., 1991; Ballon et al., 2005; Eriksson et al., 2005). The more recent studies couple a broad variety of products, services and systems into innovation activities including creation, prototyping, validating, and testing. For example, Mulder et al. (2008) include a variety of tangible and intangible innovation outcomes such as knowledge, new products and services or intellectual property rights, end-user applications, prototypes and usage patterns in living labs. In this vein, Kanstrup et al. (2010) document the creation of prototypes, which enable users to share and exchange information in daily situations including visiting in bakeries, supermarkets, and restaurants. Niitamo et al. (2012) in turn provide a small company perspective and show how an energy IT system was developed for the company. Further, in this vein, Veeckman et al. (2013) propose that an innovation outcome, such as a product or a service, is closely linked to the innovation environment and the selected innovation approach. Last, Femeniás and Hagbert (2013) propose that living labs may create a variety of value for diverse actors. The authors suggest a wide spectrum of outcomes for the living lab to be built, which cover tangible and intangible innovations from knowledge and practices to new products and concepts. To sum up tangible and intangible innovations, this study shares the view of prior studies on outcomes by underlining that innovation outcomes cover artefacts of living labs ranging between products, services or systems or their parts or prototypes. Beside the tangible outcomes, the living lab may produce intangible results such as knowledge, information, and practices. However, the main body of studies on living labs fails to clearly explain tangible and intangible innovations per se.

Many studies address a need for understanding innovations in living labs, and particularly types of innovations. For example, Kusiak (2007) uses probably the most common classification of innovations by proposing that both incremental and radical innovations exist in living labs. In accordance with the classification of innovations by Henderson and Clark (1990), Svensson and Ihlström Eriksson (2009) attempt to widen the classification from incremental and radical innovations to modular and architectural innovations. Almirall and Wareham (2011) in turn follow the suggested categorization of Bhidé (2008) that living labs generate both mid- and ground-level innovations[63], proposing also that innovations may be incremental or radical. Leminen et al. (2012b) take another perspective and distinguish factors behind the innovation mechanism by proposing a recipe for innovation in living labs. They include a strategic intention, a passion, the number of participants, knowledge and skills as well other resources to influence novelty of innovations. Again, the authors conclude that incremental innovations are the most common type of innovations and breakthrough (radical) innovations are rare in living labs.

There are few studies that attempt to expand classifications on the types of innovation, from incremental and radical innovations to other types of innovations including systemic innovation, social innovations, and technological innovations. For example, Molinari (2011) writes about work flow and the dynamic nature of systemic innovation in living labs. Schaffers and Turkama (2012) share the view of Molinari (2011) and emphasise that living labs and their ecosystems catalyse systemic innovations. They also identify product and service innovations in cross-border living labs. Liedtke et al. (2012) in turn identify market, technological and social innovations when developing and testing technologies in living labs. Edwards-Schachter et al. (2012) share they view that social innovations exist. They propose living labs as social innovation spaces, where a living lab methodology is used to identify user needs, preferences and expectations for innovation opportunities. Leminen and Westerlund (2014) take a step further by proposing that both the complexity and the heterogeneity of services and types of living labs influence expected tangible and intangible innovations. The authors claim that explorative innovations focus on supporting

[63] Bhidé (2008) categorizes innovations into high-, mid- and ground-level innovations. High-level innovations stand for building blocks and raw materials, mid-level innovations are intermediate products and components for a product, whereas ground-level innovations are knowledge or products used in consumption.

the emergence of radical innovations, while a variety of innovation strategies having exploration, exploitation or ambidexterity innovations focus on incremental innovations.

Table 7. Types of innovations and tangible and intangible innovations in living labs

Type of innovation	Tangible and intangible innovation	Source
• Not available	• Major commercial implementation • Product	Lasher et al. 1991
• Incremental and radical innovations	• Products and services	Kusiak 2007
• Not available	• Knowledge, new products and services or IPR, end-user applications, prototypes and usage patterns	Mulder et al. 2008
• Incremental and radical innovations • Architectural and modular innovations	• Products and late versions of prototypes	Svensson & Ihlström Eriksson 2009
• Technological innovations	• Prototypes	Kanstrup et al. 2010
• Mid- and ground-level innovations	• Products, services and systems	Almirall & Wareham 2011
• Not available	• Collaboration tools and practices	Budweg et al. 2011
• Systemic innovation	• Prototypes	Molinari 2011
• Social innovations	• Needs, preferences and expectations	Edwards-Schachter et al. 2012
• Technical and social innovations	-	Liedtke et al. 2012
• Incremental and radical innovations • Novelty of innovations	• Services and products • Concepts and product ideas • Methods, platforms, and technologies	Leminen et al. 2012b
• Not available	• System • User data	Niitamo et al. 2012
• Systemic innovations • Product innovations • Service innovations	-	Schaffers & Turkama 2012
• Not available	• Knowledge and practices • New products and concepts	Femeniás & Hagbert 2013
• Incremental and radical innovations	• Product, service and systems	Leminen & Westerlund 2014

To sum up, the main body of literature on living labs shares the outcomes of living labs by two different means. First, studies on living labs suggest many types of innovations. Next, studies on living labs propose both tangible and intangible

results as outcomes in living labs. Even though the scattered studies on living labs suggest different types of innovations, such studies merely describe innovations rather than offering clarifying definitions, concepts or tools to differentiate or categorise innovations by different means. In contrast, this study summarises and categorises innovations by two different means, *the types of innovations* and the *tangible and intangible innovations* in living labs, which are suggested in the literature on living labs (Table 7). More specifically, this study among many innovation studies shares their view and distinguishes between incremental and radical innovations but also includes a broad variety of tangible and intangible innovations such as products, services, systems, prototypes, concepts, knowledge, information, and practices. To conclude innovation outcomes, this study applies such "perspectives", the types of innovations and the tangible and intangible innovations, as a part of an innovation triangle of living labs as the framework of this study when developing and concluding the framework in the next chapter, Chapter 4 (see Figure 7).

4. Concluding remarks on living labs - The innovation triangle of living labs

This chapter describes the various meanings of living labs and synthesises the theoretical background of this study from the perspectives of networks, roles and innovation outcomes. The framework, an innovation triangle of living labs, summarises the three perspectives of living labs: networks, roles, and innovation outcomes.

Various meanings and interpretations of living labs

This study summarises and labels the meanings and interpretations of living labs *as a context, a method*, and *as a conceptualisation* (see Table 4). This categorisation is important, because it illuminates the assumptions in prior literature on living labs but also stresses the need for further understanding to elaborate living labs as a conceptualisation. This study positions itself in the living labs as a conceptualisation stream. Next, this study summarises conceptualisations by the three perspectives of living labs.

Three perspectives of a living lab triangle

This study considers that living labs (i) are *networks*, (ii) have different *user* and *stakeholder roles*, and (iii) generate and pursue different *types of innovation* and other outcomes, including *tangible and intangible innovation outcomes*.

(i) Literature on living labs often addresses that they are, by nature, *networks*. Prior literature documents living labs as *types of living lab networks*, and from the *actor, activity and resource perspectives*. The literature on living labs increasingly documents different *types of living lab networks* including (i) a network of living lab networks (Mavridis et

al., 2009; Dutilleul et al., 2010), (ii) a living lab in innovation system (Dutilleul et al., 2010), (iii) a cross-border living lab network (Lievens et al., 2011), (iv) the dual living lab network (Leminen & Westerlund, 2014), and (v) a single living lab network having multiple stakeholders (Feurstein et al., 2008). Third, surprisingly few attempts exist to suggest the *network structures of living labs* (cf. Vontas and Protogeros, 2009; Dong et al., 2011; Pallot et al., 2013). Extant studies distinguish connections between stakeholder(s) in networks rather than explaining or opening network structures per se in living labs.

Second, this study claims that actors, activities and resources are key elements of living labs. Even though the three elements have been widely used, the literature on living labs considers actors, activities and resources as distinct perspectives to innovation rather than viewing living labs as innovation networks characterised by actors, activities and resources as simultaneous and fundamental elements. From an *actor perspective* the main body of studies on living labs highlight multiple different stakeholders: users, providers, utilizers, and enablers, including citizens, customers, academia, consultants, city developers, companies, financiers and other organisations. Studies on living labs also cover archetypes of users, demographic users groups, and user typologies as a part of innovations in living labs (cf. Pierson et al., 2008; cf. Schuurman et al., 2010b; Lin et al., 2012b; Vicini et al., 2012b). An *activity perspective* in turn underlines a plurality of such activities including creation, development, validation and testing activities in living labs, which are associated with different network structures. The present study identifies two streams of *resource perspectives* in extant studies on living labs and labels the streams as: *collaborations enhance and strengthen the emergence of knowledge and resources,* and *conflicts are a source of new knowledge and resources*. Both streams underline and assume that collaborations take place between stakeholders; thus, they learn, share, and accumulate knowledge and resources in living labs. This study shares the view of the latter stream. This study underlines the importance of elaborating the three perspectives, actors, activities, and resources as a part of understanding innovation mechanisms in living lab networks.

To sum up the living labs as networks, there is a clear research gap in the literature on living labs from a network perspective. Therefore, this study attempts to understand and elaborate living labs from a network perspective the *types of living lab networks*, particularly the *network structures, and the actor, activity and resource perspectives in* living labs. In the rest of this study, 'a living lab' and 'a living lab network' are perceived and used as synonyms, if not clearly stressed otherwise.

(ii) The importance of users is widely accepted in studies on living labs. Scattered attempts to identify various *user roles* exist; such studies identify a *tester, a contributor*, and a *co-creator* (Hoving, 2003; Ballon et al., 2005; Boronowsky et al., 2006a; CoreLabs, 2007; Vérilhac, 2011; Sauer, 2013). However, studies on living labs are often ambiguous in explaining and defining identified user roles. Similar to the user roles, other *stakeholder roles* are rare and scattered and are thus little known in living labs (cf. Kipp and Schellhammer, 2008, Ebbesson and Svensson, 2012; 2013). Taking together stakeholder roles in living labs, the present study identifies one new stakeholder role: a *mediator,* which emerged in living labs when this study was comparing the roles to the extant classification of stakeholder roles in innovation networks by Heikkinen et al. (2007). To sum up user and stakeholder roles, prior studies on living labs include three user roles, a *tester*, a *contributor*, and a *co-creator*, and the one stakeholder role a *mediator* and twelve stakeholder roles suggested in innovation networks by Heikkinen et al. (2007) including a *webber*, an *instigator,* a *gatekeeper*, an *advocate, a producer*, a *planner,* an *entrant*, an *auxiliary, a compromiser*, a *facilitator*, an *aspirant*, and *an accessory provider*.

Extant studies on living labs are silent on role dynamics, particularly role patterns in living labs. Hence, prior studies on living labs assume that stakeholders are coupled into multiple activities, and that the same stakeholder may pursue or have multiple activities or dual and simultaneous activities (Kusiak 2007; Arnkil et al., 2010; Almirall & Wareham, 2009) rather than defining and explaining their role dynamics, particularly role patterns. Taken together, the present study underlines that, although the extant research describes user and stakeholder roles in innovation networks, user and stakeholder roles and

their role dynamics are little known in living labs and deserve more research into understanding them.

(iii) Even though living labs cover a broad continuum of innovation activities, the literature on living labs provides only scattered illustrations and typologies of *innovations*. Such studies include *types of innovations* and *tangible and intangible innovations* in living labs (cf. Kusiak 2007; Edwards-Schachter et al., 2012; Schaffers & Turkama, 2012). The present study includes them in *innovation outcomes*. Tangible and intangible innovations include products, services, systems, prototypes, concepts, knowledge, information and practices. Typically, the types of innovations are referred to as incremental and radical innovations based on their novelty.

The extant literature on networks emphasises the dependence of network structures and firm-level innovations; thus, network structures are important for innovation (Capaldo, 2007). Pittaway et al. (2004) in turn propose that networking boosts innovation outcomes, but there is still ambiguity in network configurations for successful innovation. Nieto and Santamaria (2007) found that continuity in collaboration and the composition of the collaborative network have a highly significant impact on innovation in networks. However, studies that document innovation outcomes in different network structures of living labs are nonexistent in the existing literature on living labs. More specifically, prior studies on living labs merely mention the type of the innovation without fully analysing them or linking them to other conceptualisations such as the variety of network structures or driving parties in living lab networks.

Taking together innovations in living labs, this study underlines that, although the extant research often implicitly embeds innovations as a part of living lab definitions, studies that describe innovations per se are rare in the literature on living labs. Last, this study underlines the need for understanding and revealing innovation outcomes in different network structures of living labs, particularly how network structures affect outcomes in living labs.

In the rest of this study, innovation outcomes are referenced by the types of innovation, incremental or radical, rather than distinguishing tangible and intangible product and service innovations, if not stated otherwise.

To sum up the theoretical background, this study synthetises the three perspectives of living labs, networks, roles, and innovation outcomes, to a framework: the innovation triangle of living labs (Figure 7). This study considers the framework as an integration of the perspectives on extant studies on living labs, which compile the findings of the articles in Part II rather than being the framework used in the articles per se. Thus, this study mirrors the findings of the five articles against the respective perspectives of the framework. For example, the identified user and stakeholder roles of the extant studies on living labs are mirrored to the user and stakeholder roles in the articles.

Hence, studies on living labs as networks include the types of living lab networks, the structures of living lab networks, and the actor, activity and resource perspectives. Such perspectives reveal understanding of the *first research question* of this study. Next, this study sheds light on *the second research question* of this study by elaborating user and stakeholder roles. Last, the *third research question* of this study covers the innovation outcomes but also network structures.

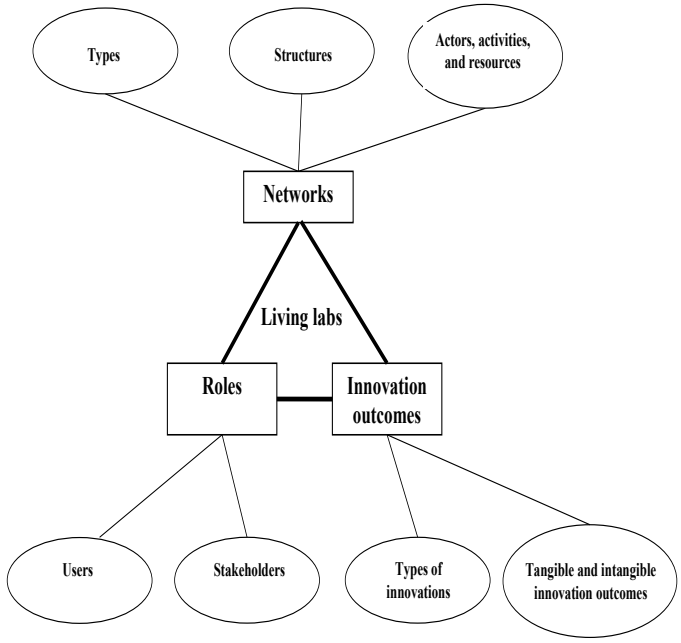

Figure 7. An innovation triangle of living labs as the framework of this study

The next chapter briefly shows the research design and methods to show the research process used in this study.

5. Research design and methodology

This chapter first describes constructivism as this study's research paradigm, abductive reasoning as its logic of understanding, and a case study approach as its empirical bases. Next, it describes the research method used to collect and analyse the data. Last, the chapter shows the reasoning and the type of research as well as the data analysis process used in the study.

5.1 A paradigm and research approaches

Kuhn (1970) argues that science evolves from one paradigm to another by replacing the existing paradigm. Paradigms include their epistemology, ontology and methodology. Guba and Lincoln (1994) position ontological, epistemological and methodological discussion into four competing paradigms: positivism[64], postpositivism[65], critical theory[66] and constructivism. Surprisingly, studies on living labs often focus on explaining living lab activities rather than directly addressing their paradigms or epistemological and ontological backgrounds (cf. Ståhlbröst, 2008; Hakkarainen, 2013; Sauer, 2013; Tang, 2014; Schuurman, 2015). This tendency may arise from the research traditions of the disciplines the

[64] Positivism explains the nature of knowledge by applying verified hypotheses, which are established from facts or laws. The ontology of positivism research is grounded on absolutely truth based on facts and the epistemology of research views that findings are true (Guba & Lincoln, 1994, 109, 113).

[65] Postpositivism explains the nature of knowledge by verifying hypotheses established as facts or laws and nonfalsified hypotheses that are probable facts or laws. The ontology of postpositivism research assumes the reality, which is critically examined but never perfectly or fully comprehendible. The epistemology of postpositivism research is grounded on facts or laws and nonfalsified hypotheses, which are probably true, but they are "always subject to falsification" (Guba & Lincoln, 1994, 109, 110, 113).

[66] Critical theory assumes that "knowledge is value mediated and hence value dependent" (Guba & Lincoln, 1994, 111). The ontology of critical theory research assumes that reality is shaped by a "congeries of social, political, cultural, economic, ethnic, and gender factors, and then crystallized (reified) into a series of structures that are now (inappropriately) taken as "real," that is, natural and immutable… are "real," a virtual or historical reality." The epistemology of critical theory views that findings are value meditated (Guba & Lincoln, 1994, 109, 111).

researchers represent. Among the few attempts, Mulder and Stappers (2009) propose that living labs differ from other cross-disciplinary approaches in their ability to interact with users. The authors include both fundamental and pure applied research in living labs. Fulgencio et al. (2012) propose that living labs are based on both design and scientific disciplines. Thus, the authors claim that science targets "a scientific truth", whereas design is grounded in experience, trial and error as well as how "*the world ought to be*, 3".

This dissertation is grounded in constructivism as its research paradigm. In contrast to other paradigms, constructivism aims to understand and reconstruct the studied reality. According to Guba and Lincoln (1994), constructivism differs from other paradigms mostly by its ontology. Thus, it includes multiple and even conflicting social realities, which depend on an individual's mental constructions that may be developed further. In other words, these constructions are not absolute truths but perceptions of investigators. Similarly, Mantere and Ketomäki (2014) claim that researchers bring their idiosyncratic reasoning practices or cognitions to studies rather than acting rationally. Guba and Lincoln (1994) describe the epistemology of constructivism, as where knowledge is created between an investigator and respondents, where realities are subjective and are grounded in the interpretations of researchers.

5.2 Research methodology, data and methods

Abductive reasoning

Inductive and deductive reasoning have their benefits and shortcomings, where the shortcomings of understanding the phenomenon or previous studies often lead to inductive reasoning, whereas deductive reasoning benefits from cumulative knowledge on previous work through reasoning but it is limited by the rigidity of previous works (Perri 6 & Bellamy, 2012). Put simply, inductive reasoning benefits from the plurality of empirical data for further conceptualisations of the phenomenon. In contrast, deductive reasoning is grounded on demonstrations or falsifications of existing conceptualisations (cf. Timmermans & Tavory, 2012). In addition to the two basic forms of reasoning, inductive and deductive, the literature depicts abductive reasoning as a third form of reasoning. Many sources underline that abduction was coined by Peirce (1878) (cf. Dubois & Gadde, 2002; Richardson & Kramer, 2006; Kovács & Spens,

2007; Timmermans & Tavory, 2012; Mantere & Ketokivi, 2013). Richardson and Kramer (2006, 500) refer to abduction as initially intended by Peirce (1955) "*the nature of scientific progress (finding new explanations for phenomena)*". Timmermans and Tavory (2012, 167) in turn refer to abduction as "*a creative inferential process aimed at producing new hypotheses and theories based on surprising research evidence*". Both of these definitions propose that abductive reasoning benefits from both inductive and deductive reasoning, where abductive reasoning as a research approach is understood as a mixture of deductive and inductive approaches (Dubois & Gadde, 2002).

Timmermans and Tavory (2012) distinguish abduction from induction and deduction. In contrast, Mantere and Ketokivi (2013) claim that all research has elements of the three types of reasoning, where researchers make inferences from a case (use deduction), in generalisations (use induction), and in explanations (use abduction). Therefore, it is crucial to explain the three types of reasoning used in tandem with others, where the authors propose normative, descriptive, and prescriptive criteria for evaluating abductive reasoning. The former criterion refers to selecting "the best explanation" and the latter, prescriptive criterion emphasises "one explanation over other". In this vein, this study applies descriptive criteria by Mantere and Ketokivi (2013), where the evaluation of abduction is grounded on transparency in its explanation. More specifically, the dissertation is transparent, starting from the very beginning with the motivations for the study, continuing on to the case selections and the systematic literature review and finally ending up with the contributions of the study, particularly when elaborating the research questions.

This study underlines abductive reasoning by two complementary means. First, Mantere and Ketokivi (2013) underline hermeneutical circles as a foundation of abduction in interpretive research, where continuous dialogue takes place between the data and the pre-understanding of the researcher. In this vein, the present study considered the results of prior articles as pre-understanding for the articles in Part II. For example, Article 1 focused on understanding living labs in a single living lab network by identifying stakeholders and their activities. The next article considered the identified stakeholders, and especially user activities, as pre-understanding when the researcher(s) elaborated a variety of user roles in the living labs networks in Article 2. Mantere and Ketokivi (2013) address the interplay between pre-understanding and empirical data and their consequential

new understanding as an evolution of researcher understanding. They label it as "reflexive narrative". Next, Kovács and Spens (2007) underline the interplay between empirical and theoretical parts and include prior theoretical (or empirical knowledge), real-life observations and theory matching, theory suggestions and conclusion in abductive reasoning. In this vein, there was a constant interplay between the empirical and theoretical parts of the articles and the empirical and theoretical parts of Part 1 in this study. Particularly, the contributions of the articles were reflected against the literature of living labs and the literature of living labs were reflected against the contributions of this study. Finally, the contributions of this study were reflected against contingency theory and the resource-based view, as described in the conclusion.

Literature review on living labs

Dixon-Woods (2011) observes that *'an authorship'* approach to reviewing literature has often dominated social sciences, whereas *'a contractual'* approach is a scientific process governed by a set of explicit rules. The systematic literature review benefits from the integration of many studies, which might otherwise be ignored. In accordance with Dixon-Woods (2011), the present study applies a study protocol of a systematic literature review covering its specific characteristics (Table 8).

Table 8. A systematic literature review protocol modified from Dixon-Woods (2011, 332)

Characteristics	**Systematic literature review applied in this study**
Study protocol	In accordance with Dixon-Woods (2011, 332)
Formal, prespecified, highly focused questions	Research questions of this study
Eligibly criteria for studies	Scientific and practitioner-based publications Selected terms "living lab, living labbing, and living laboratory" in title, abstract, and keyword list
Methods used in studies	A bibliographic search from variety of databases Reference chaining from identified publications on databases. Identification of other unpublished 'living lab publications'
Inclusion of publications against prior criteria	Topics on networks, stakeholders, roles, and innovation outcomes Only publications in English included
Formalised appraisals	Scientific and practitioner-based publications in journals, conferences, workshops, working papers and 'white papers' Scientific quality and originality of results
Explicit methods to combine findings	Content analysis of topics on networks, stakeholders, roles, and innovation outcomes, and versatile meanings and interpretations of living labs Synthesis on topics into appropriate chapters in this study

A systematic literature review was conducted to understand living labs. It was based on the analysis of scientific and practitioner-based publications. The literature review covered publications up to 15th March 2015. This study selected the terms living lab, living labbing, and living laboratory both in singular and plural form, because some databases offer different results for singular and plural forms. This study conducted a bibliographic search from the following databases; (1) Association for Computing Machinery (ACM), (2) EBSCO Business Source Complete, (3) EBSCO Business Source Elite, (4) Directory Open Access Journals (DOAJ), (5) Emerald, (6) Inderscience, (7) IEEE Xplore, (8) ProQuest ABI Inform, (9) Sage Premier, (10) Science Direct, (11) Springer Link, (12) Taylor & Francis, and (13) Wiley Online Library. The preliminary dataset encompassed the selected terms "living lab, living labbing, and living laboratory" covering title, abstract, and keyword list. The literature search resulted in number of publications on the subject of living labs publications, as shown in Table 9. The literature review also included a reference chain from identified publications on databases focused on 'living lab publications' and other unpublished 'living lab publications'. Topics on networks, stakeholders, roles, and innovation outcomes as well various meanings and interpretations of living labs were included in the literature review. Only publications in English were included. Scientific and practitioner-based publications in journals, conferences, workshops, working papers and 'white papers' were evaluated as the part of the systematic literature review. However, their scientific quality and originality with respect to the results of the topics on networks, stakeholders and their roles, and innovation outcomes as well as various definitions on living labs limit their appraisal in this study. Finally, topics on networks, stakeholders and their roles, and innovation outcomes and various meanings and interpretations of living labs were synthesised into appropriate chapters in this study. In all, 200 publications on the topic of living labs were consulted in this study.

Table 9. Sources for the literature search and review

Concept	Number of publications
Association for Computing Machinery (ACM)	65
EBSCO Business Source Complete	133
EBSCO Business Source Elite	190
Directory Open Access Journals (DOAJ)	38
Emerald	12

Inderscience	21
IEEE Xplore	140
ProQuest ABI Inform	2735
Sage Premier	12
Science Direct	67
Springer Link	1323
Taylor & Francis	26
Wiley Online Library	14
Living lab publications used in this study	200

Qualitative data gathering

The study is grounded on the extensive data set of 26 living labs, where one living lab represents one living lab case. The qualitative data gathering began from a single living lab case including seven organisations and users in its intraorganisational and interorganisational networks in Finland. The single living lab case covered 20 semistructured stakeholder interviews. In contrast to the first living labs case, the data gathering on the remaining living lab cases concentrated on the main actors in living labs (Leminen et al., 2012). Hence, covering all stakeholders in every living lab networks would have required remarkable resources for data gathering. Finally, the data set was expanded to cover an additional 25 living labs cases covering altogether 39 organisations and 103 interview subjects from Finland, Sweden, Spain and South-Africa. Appendix 4 summarises the interview themes and Appendix 5 describes the overview of living labs including brief descriptions of cases, their objectives, informants and innovation outcomes in living labs. These four countries were chosen because they were considered to be at the forefront of living lab operations and they represent a diversity of living labs, operations and resulting outcomes. Further, this study chose the living lab cases based on three criteria: (i) initiation as open innovation projects through the living lab model, (ii) include multiple actors, and (iii) innovating takes place in real-life, everyday life situations. The interviewed participants came from a variety of different levels and positions of organisations including senior management, such as CEOs, CTOs, sales directors, project managers, researchers, project coordinators, as well as users within various living labs cases. In addition to transcribed interviews and observations, the data set included secondary data in the form of web sites, bulletins, magazines, and case reports. The data set was collected between a period from 2008 to 2011 during a Finlab project and a UDOI (User Driven Open Innovation) project, such two

projects were financed by the Finnish Funding Agency for Innovation (Tekes). The data collection continued after the projects ended, but at a more limited scale.

Qualitative data analysis

This study applied an embedded case study approach. As suggested by Yin (2003, 42), the embedded case design focuses on *"more than one unit of analysis"*. The case study approach consists of both a single case study and multiple case studies, where a single case study approach and multiple case study approach are used for different purposes. More specifically, a single case study aims to understand the phenomenon, but multiple case studies are used to compare elements or conceptualisations between cases (Yin, 2003). The articles, either based on a single case study or multiple case studies, used multiple data analysis processes. The five articles were analysed and their results were theorised in the order the articles are numbered. Article 1 was conducted and published first. The article is based on empirical material from one living lab in Finland and focused on understanding multiple aspects in a single living lab. It was logical to conduct an embedded single case study first for understanding the living lab. The remaining Articles, 2 through 5, applied an embedded multiple case study approach. The study conducted a cross-case analysis between different living labs from different perspectives. The results of the analysis were documented from the perspectives of networks, roles, and innovation outcomes.

Summary of research approaches

Kovács and Spens (2007) propose that abductive research may begin either from an empirical context or existing theoretical frameworks and concepts. The data analysis of the articles began with open coding, where the data set was organised for the analysis. Next, the data analysis process continued with focused coding; thus, the data set was coded from the perspectives of the articles. The third phase of the data analysis process identified and analysed coding and compared results to theory(ies). The last phase synthesised the prior phases of data analysis process and highlighted the results. The articles used four phases in their analysis, except Article 4, which had five phases. In all, the data analysis processes used in the articles were similar.

Article 1 focuses on a living lab network and its stakeholders and their motives, outcomes and challenges of the stakeholders and possible solutions to those challenges in the living lab network. The data analysis process began with the open coding, which focused on organizing the case and identifying actors. The second round of coding focused on activities and resources. Next, the article identified motives, outcomes, and challenges of the stakeholders in living labs. Last, the article synthesised the prior phases and theorised coding. The research was based on an embedded single case study consisting of 20 interviews altogether. The data analysis process of the article was not explicitly documented to the same level of detail as in the remaining articles but was documented for the purpose of this study.

The remaining four articles used embedded multiple case data analysis, where Article 2 focused on different user roles. The data analysis process began by organising data from the research question perspectives. Next, focused coding continued on users and their activities in 26 living lab cases covering 103 semi-structured interviews in four countries. This process identified and theorised four user roles in living labs.

Article 3 concentrated on stakeholder roles and role patterns in those 26 living labs covering 103 interviews. Again, the data analysis process started with organizing data set and identifying the variety of stakeholders in the living lab networks. The focused coding applied the prior categorisation on stakeholder roles as suggested in Leminen et al. (2012a). The results of this process identified innovation dynamics and theorised four role patterns and 17 roles.

Article 4 focused on innovation mechanisms in the 26 living labs that were studied. The data analysis process began again with open coding. The dataset was organised from the research question perspectives by reidentifying all actors in those living lab cases. Next, two focused coding rounds were done; the former focused on identifying the driving actor as suggested in Leminen et al. (2012a). While the latter identified and compared Sabatier's (1986) typology of "top-down versus bottom-up" approaches, it is labelled later in this study as a participation approach to innovation activities in the studied living labs. The results of this process identified and theorised innovation mechanisms, and the previously unknown participation approach ("inhalation-dominated" versus "exhalation-dominated") was detected.

Last, Article 5 focused on network structures and their driving actors. Again, the data analysis process started with open coding, where the living lab cases were reorganised from the research question perspectives including all actors. The article had two rounds of focused coding, where the former round identified structures as suggested in Barabasi (2002) and Doz (2001) associated with living labs and the driving actors as suggested by Leminen et al. (2012a). The latter round applied the classification on innovation outcomes, more specifically the types of innovations that are incremental and radical, as suggested by Garcia and Calantone (2002) and Morgan and Berthon (2008). Last, the data analysis phase synthesised prior phases and theorised results. The fifth article was limited to 24 living labs from a possible 26 cases consisting altogether 103 due to the lack of data for describing the remaining two living lab networks.

Table 10 summaries the research approaches used in the five articles of this study. The table covers the type of *reasoning and research, data, its analysis process* and *case study approach*. These topics were discussed earlier in this chapter except for depicting the type of research (descriptive or exploratory).

This dissertation has three research questions:

- What is a living lab, from a network perspective?
- What roles do users and stakeholders have in living lab networks?
- How do network structures affect outcomes in living labs?

The first two research questions are descriptive, given that descriptive research usually answers questions of "what". The last research question is explorative, as an exploratory research focuses on questions of "why", "how" and "when". All of the articles employed both descriptive and exploratory research elements, although some of the articles did not directly address the research questions but the objectives of the articles.

Table 10. Research approaches in the study

	Articles	Type of reasoning and research	Data	Data analysis process	Case study approach
1	**Towards Innovation in Living Labs Networks**	Abductive reasoning(*)[67] Descriptive and exploratory research	Single case including 7 organisations and users 20 semistructured interviews covering all stakeholders The analysis focused on a living lab network and its stakeholders, motives, outcomes and challenges of the stakeholders and possible solutions to those challenges in the living lab network.	Four-phased data analysis process [68] (1) Open coding, (organise case and identify actors) (2) Focused coding (activities and resources) (3) Identify motives, outcome, and challenges (4) Theorizing coding (synthesised phases 1 to 3)	An embedded single case study
2	**On Becoming Creative Consumers – User Roles in Living Labs Networks**	Abductive reasoning(*) Descriptive and exploratory research	26 cases including 39 organisations 103 semi-structured interviews covering different stakeholders in four countries: Finland, South Africa, Spain and Sweden The analysis focused on different user roles and their activities.	Four-phased data analysis process (1) Open coding (organise cases) (2) Focused coding (3) Identify user roles in living lab networks (4) Theorizing the codes	Embedded multiple case studies
3	**Actor roles and role patterns influencing innovation in living labs**	Abductive reasoning(*) Descriptive and exploratory research	26 cases including 39 organisations 103 semi-structured interviews covering different stakeholders in four countries: Finland, South Africa, Spain and Sweden The analysis focused on stakeholder roles and role patterns.	Four-phased data analysis process: (1) Open coding (2)Focused coding stakeholder roles (3) Identify innovation dynamics in living labs (4) Theorizing the codes	Embedded multiple case studies

[67] Abductive reasoning refers to a mixture of inductive and deductive approaches; thus, there is an interplay between empirical and theoretical parts in the articles marked by (*).
[68] Article 1 documents the data analysis process in more general way than documented in the table.

4	**Coordination and Participation in Living Lab Networks**	Abductive reasoning(*) Descriptive and exploratory research	26 cases including 39 organisations 103 semi-structured interviews covering different stakeholders in four countries: Finland, South Africa, Spain and Sweden The analysis focused on innovation mechanisms and its coordination approach and participation approach.	Five-phased data analysis process: (1) Open coding, (2-3) Focused coding, two rounds (4) Identifying innovation in living lab networks (5) Theorizing the codes	Embedded multiple case studies
5	**The Effect of Network Structure on Radical Innovation in Living Labs**	Abductive reasoning(*) Descriptive and exploratory research	24 cases including 37 organisations 100 semi-structured interviews covering different stakeholders in four countries: Finland, South Africa, Spain and Sweden The analysis focused on network structures, driving actors and innovation outcomes.	Four-phased data analysis process (1) Open coding (2) Focused coding (3)Identify innovation outcomes in living labs networks (4) Theorizing the codes	Embedded multiple case studies

Next, Chapter 6 gives an overview of the five articles.

6. Overview of the articles and results

First, this chapter gives an introduction to the articles of this study by positioning them in relation to the themes of networks, roles and innovation outcomes. Next, the chapter summarises all five articles in individual subchapters to guide readers to their aims, research questions, methods and main findings. Last, the chapter concludes with an overview of the articles, which summarises their key findings.

6.1 Introduction to articles

The study captures the main themes of the articles: networks, roles and innovation outcomes in living labs. The articles answer the research questions relating to the main themes of this study. Figure 7 positions the main themes of the study in the five articles.

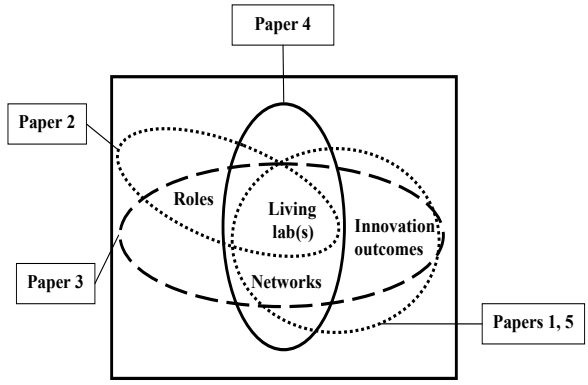

Figure 8. Positioning of the five articles

The five articles cover the three research questions of the study. This study explicitly couples its research questions to the representative research questions

of the articles. For example 1(1) refers the first article and its first research question, which is coupled to the first research question of this study. Table 11 shows the links between the research questions of the articles and the three research questions of the dissertation.

Table 11. Objectives and research questions of the articles linked into the research questions of the dissertation

Research questions of the dissertation	Research questions and aims of the articles	Article (research question)
What is a living lab, from a network perspective?	What is a living lab network? (*)[69] Aim: To describe what the living labs model is from the network perspective. Aim: To discuss the key stakeholders and their input resources in living labs networks.	1(1)
	How do living labs balance individual and mutual objectives in a living lab network? (*) Aim: To analyse the major challenges in balancing the individual and mutual objectives in living labs development work.	1(2)
	What are the different coordination and participation approaches in living lab networks?	4(1)
	How are these approaches linked to diverse living lab networks?	4(2)
	What are the structures of living lab networks? (*) Aim: To describe the different types of living lab networks. Aim: To identify the distinct structure options of living lab networks.	5(1)
What roles do users and stakeholders have in living lab networks?	What are user roles in living labs? (*) Aim: To identify and understand the dynamics related to the roles that users adopt when co-creating value with companies.	2(1)
	How is user activity related to co-creation with companies? (*) Aim: To identify and understand the dynamics related to the roles that users adopt when co-creating value with companies.	2(2)
	What are stakeholder roles in living labs? (*) Aim: To analyse roles in living labs with different perspectives to role theory.	3(1)
	How do roles affect role patterns in living labs? (*)	3(2)

[69] Some of articles include objectives of the article(s) rather than explicitly covering the more specific research question. The dissertation later forms research questions for the articles. Such research questions are marked by (*).

	Aim: To propose role patterns typical of living labs. Aim: To discuss the ways these role perspectives effect innovation in living labs.	
How do network structures affect outcomes in living labs?	How do the network structures of living labs support the emergence of innovations? (*) Aim: To bring forth propositions on how to achieve radical innovation in diverse living labs.	5(2)

Table 12 shows the focuses of the articles by summarising their objectives and research questions, where Article 1 reveals the living lab model covering the living lab network and its stakeholders. The article also discusses challenges, motives and desired outcomes of each stakeholder. Next, Article 2 creates a typology of user roles in living lab networks and documents user roles. Article 3 introduces the roles of stakeholders and highlights role patterns in living lab networks. Article 4 explores innovation mechanisms and along the dimensions of coordination and participation approaches in living labs. Last, Article 5 describes a variety of living lab network structures and their impact on innovation outcomes.

Table 12. Focus and objectives of the articles

	Article	**Focus**	**Objectives**
1	Towards Innovation in Living Labs Networks	**Understanding:** Stakeholders Challenges in living labs	(i) To describe what the Living Labs model is from the network perspective. (ii) To discuss the key stakeholders and their input resources in living lab networks. (iii) To analyse the major challenges in balancing the individual and mutual objectives in living labs development work.
2	On Becoming Creative Consumers – User Roles in Living Labs Networks	**Understanding:** User roles Dynamic related to roles	To identify and understand the dynamics related to the roles that users adopt when co-creating value with companies.
3	Actor Roles and Role Patterns Influencing Innovation in Living Labs	**Understanding:** Stakeholder roles Role patterns	(i) To analyse roles in living labs with different perspectives to role theory. (ii) To discuss the ways these role perspectives effect innovation in living labs. (iii) To propose role patterns typical of living labs.
4	Coordination and Participation in Living Lab Networks	**Understanding:** Innovation mechanisms and the dimensions of coordination and	To understand innovation mechanisms in living labs (i) What are the different coordination and participation approaches in living lab networks?

		participation approaches	(ii) How are these approaches linked to diverse living lab networks?
5	The Effect of Network Structure on Radical Innovation in Living Labs	**Understanding:** Network structure Structures supporting innovation outcomes	(i) To describe the different types of living lab networks. (2) To identify the distinct structure options of living lab networks. (3) To bring forth propositions on how to achieve radical innovation in diverse living labs.

6.2 Towards innovation in living labs networks – article 1

Article 1, Leminen, S. & Westerlund, M. (2012) "Towards Innovation in Living Labs Networks", International Journal of Product Development, Vol. 17, No. 1/2, pp. 43-59.

Article 1 aims to describe living labs from the innovation network perspective. More specifically, the article has three sub-objectives: (i) to describe what the living labs model is, from a network perspective, (ii) to discuss the key stakeholders and their input resources in living lab networks, and (iii) to analyse the major challenges in balancing the individual and mutual objectives in living labs development work.

Article 1 motivates its objectives by claiming that living labs are particularly interesting. Hence, the literature on living labs is scarce and especially there are shortcomings in understanding the characteristics of living labs. Next, the article underlines that enterprises have little knowledge and understanding of living labs and the literature is silent on an applicable user-driven model. Further, a living lab is a particularly interesting form of open innovation and offers various rationalities to be part of innovation activities. Last, a living lab enables various actors to intertwine in innovation activities and reveals its actors and their roles in the network. The article employs abductive reasoning, where the article grounds on the constant interplay between the empirical and theoretical parts. The study conducts a single case study. The study covers 20 interviews representing all actors in seven organisations being a part of innovation activities.

Article 1 makes several significant contributions for the dissertation. The article introduces *intraorganisational and interorganisational living labs* as a new conceptualisation of living labs. The contribution elaborates the first objective of the study by describing what the living labs model is, from a network perspective. The second contribution of the article is the *actor, activity and resource*

perspectives in living lab networks. The contribution elaborates the second objective of the article *by discussing the key stakeholders and their input resources in living lab networks*, particularly from the actor, activity and resource perspectives. Last, the article underlines that *collaboration and outcomes are achieved in the absence of strict objectives* in the living lab network. The contribution elaborates the third sub-objective of the article *by analysing the major challenges in balancing individual and mutual objectives in living labs development work*.

First, Article 1 proposes that living labs are innovative real-life environments, which are by nature networks. The article documents that the living lab network consists of both the *intraorganisational* and *interorganisational networks*. This finding is interesting because the article offers a new type of living lab network for the literature on living labs but the article also reveals the two networks by distinguishing and confirming previously identified stakeholders such as users, providers, enablers and utilizers in the living lab network. The finding visualises the stakeholders and explains their connections in the entire living lab network and distinguish a living lab as a multi-actor innovation network.

The second contribution of the article highlights and differentiates the *actor, activity and resource perspectives* in living lab networks, which the dissertation documents as crucial perspectives of networks (see Figure 7, an innovation triangle of living labs). This article underlines that living lab networks are the sum of its stakeholders, where the article takes a multiactor innovation network perspective. The four main key actors, or stakeholders (a user, a provider, an enabler, and a utilizer), and their activities in intraorganisational and interorganisational networks, support living labs by their 'roles'. The article explains activities of stakeholders rather than explaining stakeholder roles per se. The article identifies multiple and heterogeneous resources and skills that actors provide for the usage of living labs. The article assumes that multiple activities are linked to an actor and that activities are conducted mainly by a single party. Thus, actors and their roles are not distinct but closely interlinked. The emphasis is to illustrate stakeholders as a part of an innovation network.

Last, the article identifies motives of stakeholders (actors) to engage in living labs both from the entire network's and its key actors' perspectives. The article addresses a living lab as an open collaboration "constellation", which fosters

shared motives and goals of its stakeholders but simultaneously supports individual goals of stakeholders. Explaining the individual and mutual goals in living labs can demonstrate the *flexibility and information sharing in innovation activities, which lead stakeholders to react to incidents taking place in living labs*. The finding, the sharing of knowledge, resources and experiences, is opposite to many innovation studies, which emphasise the importance of keeping their own core competence and protecting intellectual property rights (IPR). The finding benefits the living lab network and its stakeholders by promoting flexibility. The article further claims *the need for balancing flexibility and stability*. More specifically, a living lab network enables stakeholders to participate and/or leave at any time and to adapt resource and skills to keep the accumulated knowledge.

The article emphasises the importance of a coordinator for creating value for the living labs and their stakeholders. The article suggests that living labs recover absent knowledge of a single stakeholder, thus being a "back up" and an arena for sharing knowledge when sudden personnel changes take place in a network. The article documents that stakeholders may cover and replace knowledge of a 'leaving' actor until a new actor from an organisation enters the network. The article further proposes that changes of composition or architecture in living lab networks may also result in roles and resources. The conventional innovation model and even some earlier research on living labs that argue that living labs follow a phased and linear innovation model (cf. Katzy et al., 2012a). Article 1 in turn documents that the targets of innovation activities were adjusted and readjusted during innovation activities, and that innovation activities in living labs do not have strict aims. Thus, the article underlines that the *collaboration and outcomes are achieved in the absence of strict objectives* in living labs, which is the important finding in this study.

Article 1 proposes that innovation activities are often readjusted because of *numerous unplanned changes, events and ideas*. This readjustment leads to different outcomes than expected at the beginning of innovation activities. Hence, the authors' adjustments are grounded on the expressed *undefined and latent user* needs during innovation development activities. To sum up, the article stresses that the *numerous unplanned changes, events, and ideas generated from user undefined and latent needs lead to readjusting innovation activities*. The article further argues that the adjustment resulted in richer and

more effective innovation outcomes in living labs than in conventional innovation models. This article clarifies that such innovation outcomes are tangible and intangible innovations rather than the types of innovations. Living labs pursue close collaborations with users and other stakeholders and learning between stakeholders in living labs. To sum up the contributions, Article 1 identifies the intraorganisational and interorganisational networks in the living lab. Next, the article documents the *actor, activity and resource perspectives* in living labs. Third, the article highlights that *collaboration and outcomes are achieved in the absence of strict objectives* in living labs.

Article 1 acts as the first article of this dissertation, where the living lab network is revealed. Hence, the article and its contributions offer the preunderstanding of a living lab network for the other articles. The article also articulates further needs for comparing different types of living labs, particularly to understand networks, users, other stakeholders and their roles, role patterns and innovation outcomes in living labs. The subsequent articles elaborate the future research avenues suggested in Article 1.

6.3 On becoming creative consumers – user roles in living labs networks – article 2

Article 2, Leminen, S., Westerlund, M. & Nyström, A.-G. (2014a) "On Becoming Creative Consumers – User Roles in Living Labs Networks", International Journal of Technology Marketing, Vol. 9, No. 1, pp. 33-52.

Article 2 analyses user roles in living lab networks. The article aims to identify and understand the dynamics related to the roles that users adopt when co-creating value with companies. Article 2 motivates its objective by underlining that R&D activities are increasingly taking place beyond the boundaries of R&D organisations and academic institutions. Next, companies progressively involve and integrate users as a part of companies' activities. The user roles typically focus on testing and validation activities. The article claims that there are few studies on roles in open innovation networks, particularly in living labs. Similar to Article 1, Article 2 employs abductive reasoning, where the article grounds on the constant interplay between the empirical and theoretical parts. In contrast to a prior single case study in Article 1, Article 2 is grounded on a multiple embedded case study. The article covers 26 living labs including 103 interviews representing diverse living labs in Finland, South Africa, Spain and Sweden.

Article 2 underlines two significant contributions for the objective of the article and the dissertation. First, Article 2 creates a typology of four users in living lab networks, where the article identifies four *user roles*: an *informant, a tester, a contributor* and a *co-creator*. Prior literature on living labs frequently documents a variety of user activities. Such studies implicitly propose user roles by documenting activities in living labs rather than explicitly addressing and linking activities into specific user roles including creation, prototyping, validating, and testing in living labs.

The article characterises living labs as value co-creation environments for human-centric research and innovation, in which the user role is grounded in activities in living labs and the firms' view of creation. Thus, the article proposes different user roles. The first user role, the informant, reveals a user's everyday life thus opening his/her knowledge, understanding, and opinions for the needs of a living lab. The role of the informant is similar to "a guinea pig" as suggested by Eriksson et al. (2005).

The tester is another user role in living labs, which uses, tests and validates products and services and their prototypes in real-life environments such as homes, workplaces and educational and well-being environments. The article confirms the existence of the tester user role in living labs, which prior studies on living labs identify. There are some slight differences in understanding or defining 'a tester'. In contrast to the current study, Sauer's (2013) tester role includes activities that monitor people acting with technologies. Article 2 explicitly includes real-life environments such as homes, workplaces and educational and well-being environments in its definition of a test user, while interpreting that Sauer (2013) is ambiguous in identifying such real-life environments.

Article 2 identifies a contributor and a co-creator as the third and the fourth user roles. These two user roles are similar since users have significant importance in innovation development. The article documents a co-creator as an equal stakeholder who often self-organises him/herself and who may have crucial input in an innovation development, while a contributor follows rules and instructions given by an authoritian or a top-down hierarchy in a living lab. The article confirms the existence of a 'contributor' and a 'co-creator' as the user roles extant

studies on living labs have identified. In contrast to such studies, the article explicitly differentiates two user roles of a contributor and a co-creator, and proposes explicit definitions for them. There are slight differences in understanding a contributor user role. The current study refers to such role, where a user learns with a specific design problem by creating, developing and prototyping technological artefacts (Sauer, 2013). Article 2 notes that a "*contributor collaborates intensively with other actors in the network to develop new products, services, processes and technologies,* 42". There are another slight difference between the definitions as Article 2 includes 'intensive collaboration with other actors in the network', while Sauer (2013) focuses on the specific design problems. The present study proposes a third difference, where Article 2 includes a broad variety of products, services, processes and technologies to be developed, while Sauer (2013) refers to technical artefacts.

Article 2 refers to the fourth user role*: a co-creator that is "users who co-design a service, product or process together with the company's R&D team and the other living labs actors, 43."* The present study interprets a role of a co-creator by Sauer (2013), where a co-creator suggests creating something new (a product, a service), together with other participants and is equal with other stakeholders. There are slight differences in understanding a co-creator user role as Sauer (2013) refers to a co-creator as creating 'a novelty of product and a service', while the present study includes a process among the continuum to be co-designed.

To sum up, the first contribution of Article 2 confirms the existence of prior defined user roles, a tester, a contributor and a co-creator, in living labs. Article 2 identifies a new user role, an informant. The article offers definitions of such user roles by coupling activities in living labs to the identified four user roles.

Next, the second contribution of the article introduces the *user role path towards becoming a creative consumer.* The user role path is relevant for studies on living labs, as the role path covers a continuum of user roles linked to activities. Next, the user role path integrates the dimensions of degree of user activity ("high" versus "low") and a firm´s view of co-creation ("user as a subject" versus "user as an object") when approaching a creative consumer. The user path is particularly interesting as the path introduces four user roles coupled into the firms' view of co-creation. This study argues that the created conceptualisation on a firm's view of co-creation may also be used as managerial tools, to distinguish

a desired degree of user activity. To sum up the contributions of Article 2, the article creates a typology of user roles, identifies four user roles and proposes a user role path towards becoming a creative consumer.

Article 2 and its findings offer further preunderstanding, particularly concerning the four user roles of living labs. The user and other stakeholder roles and role patterns in living labs are elaborated more in the next article, Article 3.

6.4 Actor roles and role patterns influencing innovation in living labs – article 3

Article 3, Nyström, A.-G., Leminen, S., Westerlund, M. & Kortelainen, M. (2014) "Actor roles and role patterns influencing innovation in living labs", Industrial Marketing Management, Vol. 43, No. 3, pp. 483–495.

Article 3 focuses on actor roles in living lab and reveals role patterns in living labs. The article covers three objectives: (i) to analyse roles in living labs with different perspectives from role theory, (ii) to discuss the ways these role perspectives affect innovation in living labs, and (iii) to propose role patterns typical of living labs, but the article does not include further specific research questions.

Article 3 motivates its objectives by claiming that companies comprise different partners and their resources for innovation activities rather than being the isolated efforts of companies. Next, living labs are grounded in open innovation philosophy, where users have significant roles. Last, openness and user involvement characterise innovation networks, particularly in living labs. Similar to the prior articles, the article employs abductive reasoning, where the article grounds on the constant interplay between the empirical and the theoretical parts. Further, similar to Article 2, Article 3 is grounded on multiple embedded case studies. The extensive dataset covers 26 living labs and includes 103 interviews, which represent diverse living labs in Finland, South Africa, Spain and Sweden.

Article 3 underlines significant contributions of the dissertation. First, the article suggests *multiple roles* of the stakeholders in living lab networks. The first contribution elaborates the first objective of Article 3, which aims *to analyse roles in living labs with different perspectives from role theory*. Next, the article

highlights four *role patterns* for the remaining two objectives of the article. The former objective is *to discuss the ways these role perspectives affect innovation in living labs,* and the latter is *to propose role patterns typical of living labs*. Last, the article suggests the *role and role sets as a tool for innovations,* particularly for managers and practitioners.

First, Article 3 identifies altogether *17 roles for living labs stakeholder actors* (providers, utilizers, enablers and users). The article proposes that the roles of actors indicate how the innovation activities are organised in living labs. Article 3 identifies prior identified roles in innovation networks including a *webber, an instigator, a gatekeeper, an advocate, a producer, a planner,* and an *accessory provider* (Gemünden et al., 2007; Heikkinen et al., 2007) but the roles of an *entrant*, a *compromiser* and an *auxiliary* suggested in innovation networks were not found in the living labs networks. The present study claims that living labs are grounded on collaboration and information sharing between partners, therefore the role of an *entrant* is not found. Hence, the role of entrant takes another stance by protecting its rights, and its actions may interfere with ongoing development. Given the underlying assumption of collaboration between partners, this study suggests that living labs avoid contradictions or conflicts between partners by balancing actions and relationships in an innovation network rather than having separate role, a *compromiser,* for that task in living labs. The last role, an auxiliary, takes a partial, outside role at the beginning of the innovation activities but strengthens towards the end of development activities. This study underlines that the roles of an *entrant*, a compromiser, and an auxiliary cannot be excluded; rather, they depend on behaviour of stakeholders in innovation networks not being visible in the studied living lab networks.

Later, this study identifies three additional user roles in the extant studies on living labs a *tester, a contributor,* and a *co-creator* (cf. Hoving, 2003; Ballon et al.; 2005; Boronowsky et al., 2006a; CoreLabs, 2007; Vérilhac, 2011; Sauer, 2013). However, such studies are ambiguous in explaining, defining and distinguishing the user roles as discussed in chapter 6.3.

In addition, the article identifies and labels seven previously unknown roles in living lab networks: (1) a *coordinator,* (2) a *builder,* (3) a *messenger,* (4) a *facilitator*, (5) an *orchestrator,* (6) an *integrator, and* (7) an *informant*. Roles 1

to 6 relate to all living lab actors, while role 7 refers to the roles of end users, as depicted earlier. Kipp and Schellhammer (2008) identify a *mediator*, which aligns interests and smoothes collaboration in living labs. The present study proposes that the role of mediator includes both the role of an *orchestrator* and a *messenger* identified in Article 3. Thus, the mediator role considers two roles as a role set rather than being the role as suggested in this study. Article 3 includes all stakeholder roles, where the identified user roles are similar to roles in Article 2. Stakeholder roles are important as they include activities beyond co-creation, development and validation, such as establishing close relationships between stakeholders, integrating resources or orchestrating activities. Table 13 summarises all the identified stakeholder roles in living lab networks.

Table 13. Roles in living labs network (modified from Nyström et al., 2014, 491-492)

Previously found roles in innovation networks	**Characteristics in the prior study of innovation networks**
1. Webber (similar to relationship promoter)	Acts as the initiator, decides on potential actors
2. Instigator	Influences actors' decision-making processes
3. Gatekeeper (similar to power promoter)	Possesses resources
4. Advocate	Background role, distributes information externally
5. Producer	Contributes to the development process
6. Planner	Participates in development processes; input in the form of intangible resources
7. Accessory provider	Self-motivated to promote its products, services, and expertise
Prior referred roles in living labs	**Characteristics in this study**
8. Tester (*)[70]	Tests innovation in (customers') real-life environments, e.g. hospitals, student restaurants and classrooms
9. Contributor (*)	Collaborates intensively with other actors in the network to develop new products, services, processes or technologies
10. Co-creator (*)	The user co-designs a service, product or process together with the company's R&D team and the other living lab actors
Newly identified roles	**Characteristics in this study**
11. Coordinator	Coordinates a group of participants
12. Builder	Establishes and promotes the emergence of close relationships between various participants in the living lab

[70] The study later identifies user roles in the extant studies of living labs marked by (*).

13. Messenger	Forwards and disseminates information in the living lab network
14. Facilitator	Offers resources for the use of the network
15. Orchestrator	Guides and supports the network's activities and continuation; tries to establish trust in the network to boost collaboration in line with the living lab's goals
16. Integrator	Integrates heterogeneous knowledge, development ideas, technologies or outputs of different living lab actors into a functional entity
17. Informant	Brings users' knowledge, understanding and opinions to the living lab

The *coordinator* coordinates a network of living lab actors, meaning a group of participants, and thus acts as a "focal network hub". The coordinator collects information and organises stakeholders´ (i.e., users, user communities and providers) about their needs, requirements, and desires as well addresses the collected information to a living lab network and its participants. Coordinators represent a specific group of actors (such as users) that have authority in their group and are thus able to influence the whole group). The *builder* encourages and promotes collaborative relationships between the different parties, e.g. between users and companies, by supporting action that builds trust. A builder has similarities to a relationship promoter (Gemünden et al., 2007) when establishing internal and external connections, and a webber (Heikkinen et al., 2007). However, a webber has power to decide and incorporate actors in network, while a builder does not.

The *messenger* first collects development ideas from different groups of actors in living labs such as coordinators and users groups and then distributes and disseminates the ideas and information for use by living lab network actors. The *facilitator* facilitates and helps living lab actors such as users or user communities to accomplish their aims or navigates innovation activities in appropriate direction(s). The role of a facilitator differs from the prior identified role of the facilitator by Heikkinen et al. (2007). Whereas Heikkinen et al. (2007) propose that a facilitator offers and brings the resources for the usage of the network, the article stresses that a facilitator instructs and motivates user group(s) with close co-operation in anticipated directions. The facilitator fosters user innovativeness for innovation development in living labs. The *orchestrator* guides and supports all the living lab actors by orchestrating activities and continuation in a living lab network. The orchestrator initiates and supports actors' activities for the good of the network. However, the orchestrator supports

the actors in the network by acting as an example and by encouraging them rather than exercising power over the others. Further, the orchestrator attempts to foster trust by boosting collaboration in a living lab network. The roles of the orchestrator and the facilitator have similarities: whereas the orchestrator steers the entire living lab network, the facilitator supports the innovation activities of user groups. The *integrator* merges and combines a functional entity of a developed product, a service or a system by integrating heterogeneous knowledge, development ideas, technologies and outputs of all the living lab actors. The *informant* brings users knowledge, understanding and opinions to the living lab. The contribution of the identified roles is significant as conventional network roles have been documented in networks (cf. Heikkinen et al., 2007) but prior studies on living labs are silent on stakeholder roles, and there are some scattered studies on user roles. Article 3 introduces roles and role sets in open innovation network and particularly in living labs.

The second significant contribution of Article 3 highlights and differentiates four *role patterns* of living labs: (i) *ambidexterity*, (ii) *reciprocity*, (iii) *temporality*, and (iv) *multiplicity* (Table 14). The *role ambidexterity* means that actors pursue both role-taking and role-making. In other words, an actor may take or make their roles in a network. Article 3 proposes that role ambidexterity is one form of earlier labelled contextual ambidexterity in organisations. *Role reciprocity* in turn means that an actor's role leads to the position, and the position leads to a role in living labs. The third role pattern, *role temporality,* illustrates changes of actors' roles with respect to network changes. The last role pattern, *role multiplicity,* symbolises the various roles actors have in living labs.

Table 14. Role patterns in living lab networks

New identified role patterns in living lab networks	Characteristics in this study
Role ambidexterity	Actors pursue both role-taking and role-making
Role reciprocity	An actor's role leads to the position of the role in the network, and, conversely, the position leads to a specific role.
Role temporality	Actors' roles change as the network changes
Role multiplicity	Actors hold multiple roles in a living lab network

The contribution of role patterns is important, as the extant studies on living labs are silent on role patterns. This is not surprising, because as highlighted

earlier in this chapter, there are some scattered studies on roles and particularly stakeholder roles in literature on living labs. Such studies are ambiguous in defining and explaining both roles and role dynamics in living lab networks. In contrast, this study explicitly identifies, defines and explains four role patterns in living labs networks. The extant literature on living labs often explains activities of stakeholders rather than stakeholder roles. Extant studies on living labs assume that stakeholders are coupled into multiple activities, and that the same stakeholder may pursue or engage in multiple activities (Kusiak 2007; Arnkil et al, 2010; Almirall & Wareham, 2009). Among them, Almirall and Wareham (2009) underline dual and simultaneous activities (roles[71]) of users. Such prior studies indicate that stakeholders undertake multiple activities but also dual and simultaneous activities of users. More specifically, Almirall and Wareham (2009) implicitly refer to role multiplicity by dual and simultaneous activities of users rather than by explicitly defining and explaining role multiplicity in living labs per se.

Last, the third contribution of Article 3 proposes that, by understanding roles and role patterns in living labs, scholars and practitioners learn to build, utilise, and orchestrate open innovation networks, where the *role and role sets as a tool for innovations* particularly should be considered as tools for managers and practitioners. To sum up the contributions, Article 3 identifies altogether 17 *roles*, of which seven were previously unidentified. Next, the article identifies the four *role patterns* in living labs. Last, the article suggests the *role and role sets as tools for innovations,* particularly for managers and practitioners.

Article 3 and its findings offers again the further preunderstanding of living labs of this study for the studied living labs networks in Article 4.

6.5 Coordination and participation in living lab networks – article 4

Article 4, Leminen, S. (2013) "Coordination and Participation in Living Lab Networks", Technology Innovation Management Review, Vol. 3, No. 11, pp. 5–14.

Article 4 aims at understanding innovation mechanisms in living labs. The article has two specific research questions; (i) what are the different coordination

[71] The authors are ambiguous in defining roles; they refer to a role as an activity in which a stakeholder participates.

and participation approaches in living lab networks? and (ii) how are these approaches linked to diverse living lab networks?

Article 4 motivates its objective by highlighting that previous literature on living labs emphasises the users but the existing discourse lacks an innovation mechanism, particularly in diverse living lab networks. In addition, prior literature on open innovation calls for further conceptual clarifications. Further on, living labs emphasise the importance of users and the diverse roles played by them and other stakeholders. Last, extant studies couples driving actors to types of living labs rather than attempting to distinguish living labs by their innovation mechanisms. Similar to the prior articles, particularly Articles 2 and 3, Article 4 employs abductive reasoning, the interplay between the empirical and theoretical parts, and is grounded in multiple embedded case studies. The extensive dataset covers 26 living labs and includes 103 interviews, which represents diverse living labs in Finland, South Africa, Spain and Sweden.

Article 4 emphasises significant contributions of the dissertation. First, the article distinguishes coordination and participation, which elaborates the first objective of the article: *what are the different coordination and participation approaches in living lab networks?* Second, the article highlights *a matrix of innovation mechanisms in living labs*, which elaborates the second research question: *how are these approaches linked to diverse living lab networks?* Last, the article suggests the *matrix of innovation mechanisms,* particularly as *a tool for managers and practitioners*.

First, Article 4 investigates living labs and compares them to a typology of Sabatier (1986), including top-down and bottom-up approaches. The article proposes that open innovation, coined by Chesbrough (2003), is grounded in innovation management from a company perspective, meaning a top-down approach. In contrast, von Hippel (2007) takes an opposite perspective, a bottom-up approach, in which users or user communities focus their needs rather than a companies' needs in user innovation networks. Such perspectives implicitly depict top-down and bottom-up approaches rather than explicitly addressing them.

Article 4 claims that *"a top-down approach is merely led or coordinated to accomplish centralized and official targets, whereas a bottom-up approach*

operates at the grassroots level and focuses on local needs, 8". The article claims that the two approaches form an opposite ends of *coordination approach* in living labs. Coordination of living labs activities in turn refers organizing activities by the means of top-down or bottom-up. Given that current classifications on innovation literature (e.g. Bogers & West, 2010; Dahlander & Gann, 2010; Huizingh, 2011) do not cover inhalation-dominated and exhalation-dominated innovations. Article 4 coins and introduces *inhalation-dominated and exhalation-dominated innovations* into the innovation literature. The inhalation-dominated approach fulfils the needs of driving parties, whereas the exhalation-dominated approach emphasises the wishes of other stakeholders, not the driving party. The inhalation-dominated and exhalation-dominated innovations were invented from the case analysis. The article underlines that inhalation-dominated and exhalation-dominated innovations form opposite ends of *participation approaches* in living labs. The participation approach refers to the target of innovation activities in living labs.

Second, the study introduces a framework: *the matrix of innovation mechanisms in living labs*. The developed framework identifies and analyses the four previously identified types of living lab networks including provider-driven, enabler-driven, utilizer-driven and user-driven living labs. The article highlights that living lab networks assume various forms of participation and coordination, whereas the developed framework includes two dimensions: a *coordination approach* ("top-down" versus "bottom-up") and a *participation approach* ("inhalation-dominated" versus "exhalation- dominated") and links these two approaches to four prior identified types of living lab networks. The living labs networks include user-, utilizer-, provider-, and enabler-driven living labs (cf. Leminen et al., 2012a). Our article addresses that provider-driven and utilizer-driven living labs are top-down coordinated, which means that innovation activities are typically directed and controlled from the top down. In opposite to that, user-driven and enabler-driven living labs are characterised by bottom-up coordination of the development, creation and validation of ideas at the grassroots level. This article associates with the provider-driven and enabler-driven living labs as exhalation-dominated innovations in the participation approach. Enabler-driven living labs provide outcomes for the needs of region(s), its associations, its occupants and its user communities. The study identifies the utilizer-driven and user-driven living labs as inhalation-dominated innovations in the participation approach. The utilizer-driven living lab typically directs,

controls and initiates from the top to down, and follows an inhalation-dominated approach and a utilizer typically uses a living lab as 'a mechanism and resource spring' to develop and create new ideas, concepts, or prototypes or to validate and test concepts, products, and services. In contrast, a user-driven living lab is grounded on an assumption to improve everyday life conditions or activities of local users, and development needs appear from individual users or a user community and the results or findings of innovation activities are delivered for the need of the users or user community. Prior literature on living labs provided scattered studies on top-down and bottom-up approaches, as documented in the article. However, the discourse does not link these two types of living labs. This article makes a contribution to the literature on living labs by linking top-down and bottom-up approaches to coordination approaches for the diverse types of living lab networks.

Last, the third contribution of Article 4 proposes that, by understanding coordination and participation approaches in living labs, scholars and practitioners can pursue an appropriate approach in a variety of open innovation networks, where the *matrix of innovation mechanisms* is *a tool,* particularly for managers and practitioners. To sum up, (i) the findings highlight and introduce the matrix of innovation mechanisms in living lab networks. The framework developed in this study is grounded on two dimensions: the coordination approach ("top-down" versus "bottom-up") and the participation approach ("inhalation-dominated" versus "exhalation- dominated"). The study integrated four previously identified types of living lab networks (e.g. in Leminen et al., 2012) into the introduced framework. (ii) This study introduces inhalation-dominated and exhalation-dominated innovations in the innovation literature. (iii) Provider-driven and enabler-driven living labs are associated with exhalation-dominated innovations in the participation approach, while utilizer-driven and user-driven living labs are identified with inhalation-dominated innovations in the participation approach.

Article 4 and its findings of innovation mechanisms offer further preunderstanding of living labs in the studied living lab network structures in Article 5. Thus, Article 4 highlights the different innovation mechanisms in living labs networks. Such an underlying assumption leads to descriptions of the different types of living labs networks in the last article.

6.6 The effect of network structure on radical innovation in living labs – article 5

Article 5, Leminen, S., Westerlund, M., Nyström, A.-G. & Kortelainen, M. (2015a in press) "The Effect of Network Structure on Radical Innovation in Living Labs", Journal of Business Industrial Marketing (JBIM)

Article 5 focuses on the ways living labs are structured and organised for innovation by investigating the actors that drive the activities in the living lab network. The article has three objectives: (i) to describe the different types of living lab networks, (ii) to identify the distinct structure options of living lab networks, and (iii) to bring forth propositions on how to achieve radical innovation in diverse living labs networks.

Article 5 motivates its objective by highlighting that new paradigms affect the way networks operate, where opening-up innovations represents the most remarkable paradigm change. Next, the benefits of open innovation are widely accepted and there is a particularly interesting form of open innovation network: a living lab network. However, the literature on understanding structures of living lab networks and innovation outcomes in those networks is scant. Similar to the prior articles, the article employs abductive reasoning. Further, Article 5 is grounded on multiple embedded case studies. The extensive dataset covers 24 living labs and includes 100 interviews, which represent diverse living labs in Finland, South Africa, Spain and Sweden.

Article 5 highlighted significant contributions of the dissertation. First, the article suggests *a framework for analysing the configuration modes of living lab networks*. The first contribution elaborates the first and second objectives of Article 5. The former *describes the different types of living lab networks*, whereas the latter identifies the *distinct structure options of living lab networks*. Next, the article addresses that *the network structures support types of innovations in living lab network.*[72] The second contribution reveals the third objective of the article by *propositioning how to achieve radical innovations in diverse living labs networks*. Last, the paper suggests the *framework for analysing the configuration modes of living lab networks* is a *tool,* particularly for managers and practitioners.

[72] Article 5 refers the types of innovations as a novelty of innovation *("i.e. whether the innovation outputs were radical or incremental by nature, p. 9").*

First, the article draws on a two-dimensional *framework for analysing the configuration modes of living lab networks*. The article categorises three types of network structures (centralised, distributed and multiplex) as proposed in Barabasi (2002). This finding is interesting as Article 5 confirms that such categories exist in living labs. The other findings are also interesting as prior studies on living labs include scattered studies on networks, but within the scope of the current study such studies do not explain the network structures of living labs. Further, Article 5 investigates and distinguishes innovations related to the driving parties in living lab networks and includes an orchestration typology of living labs that is *utilizer-driven, enabler-driven, provider-driven* and *user-driven living labs* (Leminen et al., 2012a). As a result, the article identifies a 3x4 matrix. More specifically, 12 potential configuration modes of living lab networks are depicted and also include both incremental and radical innovations in these configurations. This contribution is important: there is scarce understanding on how living labs are structured and organised. Prior studies on living labs have not coupled network structures and parties to driving parties of innovation activities.

Next, the second contribution of Article 5 addresses that the *network structures support types of innovations* in living lab network. The article addresses three propositions, which are drawn from configurations modes in living labs: the *distributed multiplex network structure supports radical innovation, the driving actor affects the living lab network's innovation outcome,* and *strategic objectives affect the innovation outcome*. The first proposition underlines that the emergence of radical innovations are associated with the distributed multiple network structures fostering knowledge and information exchange and collaboration between multiple actors in living lab networks, whereas distributed and centralised network structures support the emergence of incremental innovations.

The second proposition highlights that *the driving actor affects the living lab network's innovation outcome*. And the third proposition of the study, *strategic objectives affect the innovation outcome* proposes that the type of innovation depends on the driving actor in addition to objectives. The article addresses that both the enabler-driven and user-driven living labs focus on everyday life problems often addressed by e.g., fishermen, elderly, farmers, or a user community in a regional development initiative. Providers and utilizers in turn

focus on emerging everyday life problems of users but also align goals strategically. Therefore, provider-driven and utilizer-driven living lab networks may engendered radical innovations.

Last, the third contribution of Article 5 suggests that the classification enables scholars and practitioners learn to build, utilise, and orchestrate open innovation networks, where the *framework for analysing the configuration modes of living lab networks* particularly should be considered as a tool for managers and practitioners. More specifically, the classification tool makes sense for participating in innovation activities in living labs, and provides a managerial foundation for the governance of living labs. To sum up the contributions, Article 5 draws on (i) the two-dimensional framework for analysing the configuration modes of living lab networks. Next, (ii) the article highlights that the network structure supports the type of innovation in a living lab network. Thus, the found case examples indicate that the distributed multiple network structure supports the emergence of radical innovations in networks. This study proposes that the type of innovation depends on the driving actor and objectives. Last, the article suggests that the *framework for analysing the configuration modes of living lab networks* is *a tool,* particularly for managers and practitioners.

6.7 Summarising the articles

The five articles advance the insights of living labs from the networks, roles and innovation outcomes perspectives. Table 15 summarises the five articles by their objectives and main findings.

Table 15. Main findings of the articles

	Article	Objectives and research questions	Main findings
1	Towards Innovation in Living Labs Networks	(I) To describe what the living labs model is from the network perspective. (II) To discuss the key stakeholders and their input resources in living labs networks. (III) To analyse the major challenges in balancing the individual and mutual objectives in living labs development work. (i) What is a living lab network? (*)[73] (ii) How do living labs balance individual and mutual objectives in a living lab network? (*)	(i) A living lab network includes both intraorganisational and interorganisational networks. (ii) The actor, activity and resource perspectives reveal a living lab network. (iii) Collaboration and outcomes in the living lab network are achieved in the absence of strict objectives.
2	On Becoming Creative Consumers – User Roles in Living Labs Networks	To identify and understand the dynamics related to the roles that users adopt when co-creating value with companies. (i) What are user roles in living labs? (*) (ii) How is user activity related to co-creation with companies? (*)	(i) A typology of four users in living lab networks was created. The user roles are an informant, a tester, a contributor and a co-creator, of which a tester, a contributor and a co-creator are previously identified in the studies of living labs. (ii) The user role path towards becoming a creative consumer is introduced. The user role path integrates the dimensions of: degree of user activity ("high" versus "low") and firm´s view of co-creation ("user as a subject" versus "user as an object") when approaching creative consumers.
3	Actor Roles and Role Patterns Influencing Innovation in Living Labs	(I) To analyse roles in living labs with different perspectives to role theory. (II) To discuss the ways these role perspectives effect innovation in living labs. (III) To propose role patterns typical of living labs.	The findings highlight and introduce altogether (i) 17 roles for living actors (providers, utilizers, enablers and users). Seven new roles were identified and ten of these roles were previously identified in the studies on innovation networks or living labs. The findings highlight (ii) four role patterns of living labs: (1) ambidexterity, (2) reciprocity, (3) temporality and (4) multiplicity.

[73] Some of articles include objectives of the article(s) rather than explicitly covering the more specific research questions for the objectives. The dissertation later forms research questions for the articles. The research questions are marked by (*).

		(i) What are stakeholder roles in living labs? (*) (ii) How do roles affect role patterns in living labs? (*)	
4	Coordination and Participation in Living Lab Networks	To understand innovation mechanisms in living labs (i) What are the different coordination and participation approaches in living lab networks? (ii) How are these approaches linked to diverse living lab networks?	The findings (i) highlight and introduce the matrix of innovation mechanisms in living lab networks. The framework developed in this study is grounded on two dimensions: the coordination approach ("top-down" versus "bottom-up") and the participation approach ("inhalation-dominated" versus "exhalation-dominated"). The study integrates four previously identified types of living lab networks (e.g. in Leminen et al., 2012a) into the introduced framework. This study introduces (ii) inhalation-dominated and exhalation-dominated innovation into the innovation literature. The findings underline that (iii) provider-driven and enabler-driven living labs are associated with exhalation-dominated innovation in the participation approach, whereas utilizer-driven and user-driven living labs are identified with inhalation-dominated innovation in the participation approach.
5	The Effect of Network Structure on Radical Innovation in Living Labs	(I) To describe different types of living lab. (II) To identify the distinct structure options of living lab networks. (III) To bring forth propositions on how to achieve radical innovation in diverse living labs. (i) What are the structures of living lab networks? (*) (ii) How do the network structures of living labs support the emergence of innovations? (*)	(i) A two-dimensional framework for analysing the configuration modes of living lab networks is presented. (ii) The network structure supports the type of innovation in living lab networks. Thus, the found case examples indicate that the distributed multiple network structure supports the emergence of radical innovations in networks. The study proposes that the type of innovation depends on the driving actor and objectives.

Next, Chapter 7 concludes the key arguments of the study and shows the theoretical contributions and the managerial implications of the dissertation.

7. Discussion and conclusions

This chapter first presents the main propositions of the dissertation for the literature of living labs and, more generally, for open innovation networks. Next, it highlights the theoretical contributions and suggests propositions for open innovation networks, and particularly for living labs. Third, the chapter describes the implications for contingency theory and the resource-based view. The chapter concludes the discussion of propositions for and from the research traditions. Furthermore, the managerial implications of the dissertation are discussed. The chapter also discusses extant doubts and critiques of living labs and evaluates the relevance of the study as well as showing its limitations. Finally, the chapter proposes some topics for future research.

7.1 Propositions of the dissertation

This study claims that living labs are multiperspective theoretical constructs. This study suggests nineteen propositions (Table 16). Altogether, seventeen propositions, propositions (1)-(13), (14)-(17), are associated with open innovation networks and literature of living labs in particular. The study underlines thirteen propositions, propositions (1)-(13), supported by the contributions of the study concerning the networks, roles and role patterns in living labs and their innovation outcomes for the literature of living labs but also contingency theory and the resource-based view. In addition, this study suggests two propositions from contingency theory, (14)-(15), and two propositions from the resource-based view (16)-(17) for the future studies of living labs. Last, this study suggests two additional propositions (18)-(19) from the existing literature on living labs to inform future studies of the resource-based view.

Table 16. Propositions of the dissertation

#	Propositions	Living labs networks Chapter revealing the propositions	Contingency theory Chapter revealing the propositions	The resource-based view Chapter revealing the propositions
For the literature on living labs, contingency theory, and the resource-based view				
(1)	An open innovation network seeks a novel and an unforeseen innovation outcome by not setting strict objectives for innovation outcomes.	Chapter 7.2.1 Living lab networks	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(2)	An open innovation network attempts to accelerate innovation activities by sharing the knowledge, resources, and experiences and learnings across stakeholders and users and from real-life environments.	Chapter 7.2.1 Living lab networks	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(3)	An absence of a strict objective increases the need to flexibly acquire new knowledge and resources for the innovation activities in open innovation networks.	Chapter 7.2.1 Living lab networks	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(4)	Predefined stakeholder roles decrease the complexity of innovation activities, where decreasing complexity leads to predefined incremental innovation outcomes in open innovation networks.	Chapter 7.2.2 User and stakeholder roles, and their role patterns	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(5)	Increasing complexity of innovation activities, fostering dynamic and learning between stakeholders, and adapting a broad continuum of roles and role patterns in innovation activities increase the likelihood of an emergence of an undefined and a novel innovation outcome in open innovation networks.	Chapter 7.2.2 User and stakeholder roles, and their role patterns	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view

(6)	Role-taking leads to predefined roles in predefined centralised and decentralised network structures, and being a stakeholder in centralised and decentralised network structures leads to predefined roles in open innovation networks.	Chapter 7.2.2 User and stakeholder roles, and their role patterns	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(7)	Role-making opens up a continuum of roles in a distributed multiple network structure and being a stakeholder in the distributed multiple network structure enables nonpredefined roles in open innovation networks.	Chapter 7.2.2 User and stakeholder roles, and their role patterns	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(8)	A distributed multiple network structure increases the likelihood that a radical innovation will emerge in open innovation networks.	Chapter 7.2.3 Innovation outcomes	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(9)	Distributed and centralised network structures increase the likelihood that an incremental innovation will emerge in open innovation networks.	Chapter 7.2.3 Innovation outcomes	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(10)	Provider-driven and utilizer-driven networks increase likelihood of an emergence of a radical innovation in open innovation networks.	Chapter 7.2.3 Innovation outcomes	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(11)	User-driven and enabler-driven networks increase the likelihood that an incremental innovation will emerge in open innovation networks.	Chapter 7.2.3 Innovation outcomes	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(12)	A user role of a co-creator increases the likelihood that a radical innovation will emerge in open innovation networks.	Chapter 7.2.3 Innovation outcomes	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
(13)	A user role of an informant, a tester, and a contributor increases the likelihood an incremental innovation will emerge in open innovation networks.	Chapter 7.2.3 Innovation outcomes	Chapter 7.4.2 Implications for and from contingency theory	Chapter 7.4.3 Implications for and from the resource-based view
From contingency theory to the literature of living labs				
(14)	Strategic contingencies and contingency variables strengthen the understanding of a uniqueness of	**NA**	Chapter 7.4.2 Implications for and from contingency theory	**NA**

	innovation activities, and how innovation activities are coupled to innovation strategies in living labs.			
(15)	Diverse and contradictory contingencies of a real-life environment increase the likelihood that innovation activities will be strenthened and that an innovation outcome will emerge in open innovation networks.	**NA**	Chapter 7.4.2 Implications for and from contingency theory	**NA**
From the resource-based view to the literature of living labs				
(16)	An open innovation network strengthens the potential for an emergence of a novel innovation outcome, when stakeholders share and develop rare and invaluable resources beneficial for innovation outcomes	**NA**	**NA**	Chapter 7.4.3 Implications for and from the resource-based view
(17)	Increasing density of a network increases the flow of information and other resources between stakeholders in open innovation networks.	**NA**	**NA**	Chapter 7.4.3 Implications for and from the resource-based view
From the literature on living labs to the resource-based view				
(18)	An open innovation network enables a company to access valuable, rare and imperfectly imitable resources and develop them with other stakeholders; such resources are otherwise unattainable in a restricted boundary of innovation activities controlled by a company.	**NA**	**NA**	Chapter 7.4.3 Implications for and from the resource-based view
(19)	An organisation improves its innovation activities by seeking to facilitate them beyond their organisational boundaries rather than controlling such activities in open innovation networks.	**NA**	**NA**	Chapter 7.4.3 Implications for and from the resource-based view

The theoretical contributions, defined concepts and managerial tools of the study are summarised in Figure 8. They are described in more detail in the following subchapters.

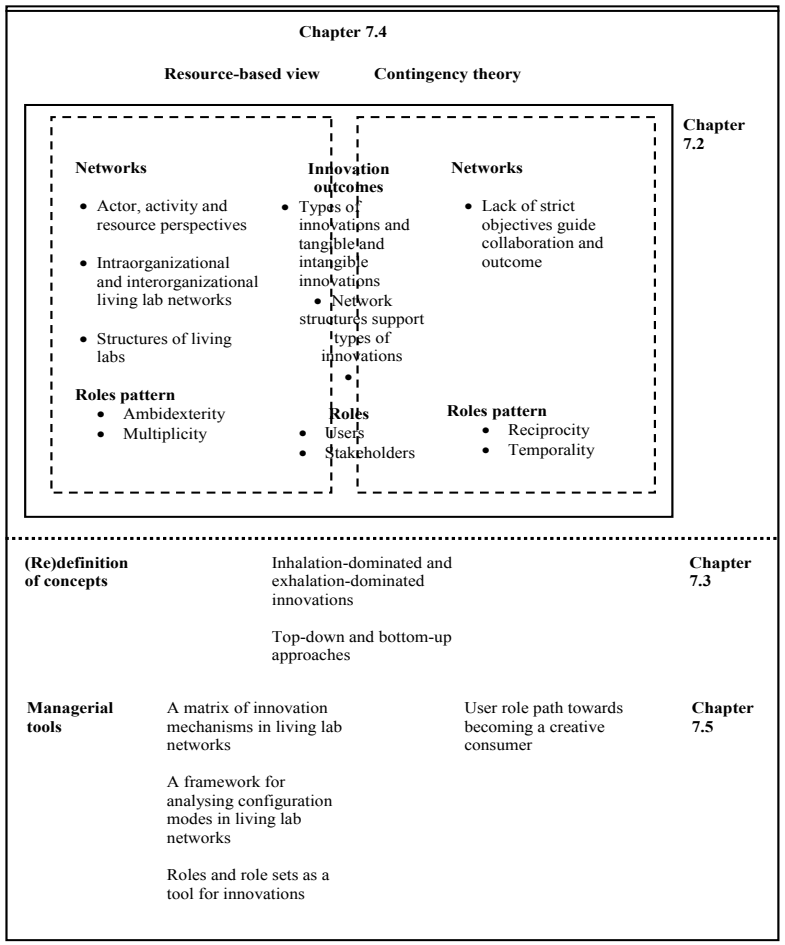

Figure 9. The contributions of the study

7.2 Theoretical contributions to living labs

This subchapter shows the theoretical contributions from the three perspectives of the study: networks, roles and innovation outcomes. The

subchapter concludes the discussion of the thirteen propositions that are based on the theoretical contributions of this study, as relevant to the literature on innovation networks, particularly on living labs.

7.2.1 Living lab networks

Literature on living labs documents living lab networks by different means including the *actor, activity and resource perspectives*, the *types of living lab networks*, and the *network structures of living labs*. This study highlights that *collaboration and outcomes are achieved in the absence of strict objectives*, which is one of the most crucial findings of this study.

Collaboration and outcomes achieved in the absence of strict objectives

In opposition to conventional innovation and even some earlier research on living labs, this study documents that the *numerous unplanned changes, events and ideas generated from user with undefined and latent needs leads to the readjusting innovation activities*. The unplanned changes, events and ideas are created and formed as a part of innovation activities with stakeholders in living labs. More specifically, this study proposes that, instead of having a fixed goal, the goal is adjusted and readjusted based on the results and the ongoing activities in the living lab. The study further underlines the meaning of collaboration and information sharing when forming both intraorganisational and interorganisational networks, where the living lab itself and participating actors balance both mutual and individual goals and motives. More specifically, this study argues that the balancing of both mutual and individual goals ensures participation in innovation activities and sharing knowledge with other stakeholders in living labs. Thus, by sharing and revealing information and knowledge, the benefits of flexibility in a living lab network can be acquired. Stakeholders in living lab networks have learnt to share their knowledge with the other participants in the networks, w*here flexibility and information sharing enables stakeholders to react incidents taken place in living labs.*

Prior literature on living labs acknowledges and describes an iterative approach. For example, Lin et al. (2012a) propose that living labs open a context of everyday life to experimentation, which enhances discovery and change. Accordingly, studies often recognise the importance of adapting

incidents (e.g. Ståhlbröst, 2008; Pierson & Lievens, 2005). In fact, Ståhlbröst and Bergvall-Kåreborn (2008) stress that iterations and interactions, which take place between phases as well as between stakeholders, foster innovation developments. Iterations between phases enable a shift and narrowing of focus of development in an individual phase. Panek and Zageler (2009) in turn propose that a target of innovations may be adapted or an unexpected barrier may change a target significantly in a design process in living labs.

Even though earlier literature on living labs has identified the importance of an iterative approach, such studies fail to address the *flexible and loose objectives collaborative approach* in living lab networks. This study underlines that *the sharing of knowledge, resources and information promotes flexibility*. The prior studies on living labs share the opposite assumption. Among them, Katzy et al. (2012) propose that a linear innovation model systematically attempts to avoid or minimise interaction between the phases, while living labs attempt to avoid misunderstandings between phases by sharing knowledge using multiple teams. In addition, a few studies propose that the uncontrollable dynamics of everyday life are the source of complexities in real-life environments (cf. Hoving, 2003; Boronowsky et al., 2006a, 2000b). Sauer (2013) proposes that unforeseen ideas and practices are revealed through situated expertise and improvisation in living labs. The present study emphasises that, by sharing the knowledge, resources and experiences all the living lab networks, the benefits of open innovation networks can be realised. This result is opposite to many innovation studies that emphasise the importance of keeping their own core competence and protecting intellectual property rights.

To sum up, collaboration and outcomes are achieved in the absence of strict objectives in living labs. This study argues that this results in richer and even more effective innovation outcomes in living labs than what has been claimed in conventional innovation models, because living labs pursue close collaborations with users and other stakeholders and learning between stakeholders. This study forms three propositions for future studies of open innovation networks and particularly living labs:

Proposition (1): An open innovation network seeks a novel and an unforeseen innovation outcome by not setting strict objectives for innovation outcomes.

Proposition (2): An open innovation network attempts to accelerate innovation activities by sharing the knowledge, resources, and experiences and learnings across stakeholders and users and from real-life environments.

Proposition (3): An absence of a strict objective increases the need to flexibly acquire new knowledge and resources for the innovation activities in open innovation networks.

Identified new types of living lab networks

This study introduces an additional type of living lab networks: *a living lab consisting of intraorganisational and interorganisational networks*. The prior literature on living labs have shown the following *types of living lab networks*: (i) a network of living lab networks (Mavridis et al., 2009; Dutilleul et al., 2010), (ii) a living lab in innovation system(s) (Dutilleul et al., 2010), (iii) a cross-border living lab network (Lievens et al., 2011), (iv) a single living lab network having multiple stakeholders (Feurstein et al., 2008), and (v) the dual living lab network (Leminen & Westerlund, 2014). The living lab consisting of intraorganisational and interorganisational networks refers to a living lab where stakeholders form a network, and further, the entire network is coupled to other living labs. To sum up, this study underlines that the intraorganisational and interorganisational networks provide an additional way to classify the types of living lab networks, hence they elaborate the networks of a single living lab.

Confirmed centralised, decentralised or distributed networks structures

This study confirms, in accordance with the classification of Barabasi (2002), that *centralised, decentralised or distributed networks* structures exist in living lab networks. Prior literature on living labs has provided a few scattered attempts to distinguish the network structures of living labs. This study further shows that the classification can be used to analyse innovation activities in living labs. This study creates a conceptual framework, which

typifies innovation network structures and the variety of living labs based on driving parties.

Confirmed actor, activity and resource perspectives

Actors, activities and resources as single elements have been widely documented in the literature on living labs. This study in turn sheds light on our understanding of living lab networks by proposing that the *actor, activity and resource perspectives* are useful perspectives for understanding living lab networks. Thus, actor, activities and resources are embedded in living lab networks. Thus, living lab networks have a plurality of different stakeholders and actors. This study underlines that, beyond actors, it is important to study activities and resources in order to understand innovation mechanisms in living labs.

7.2.2 User and stakeholder roles and role patterns

This study contributes to the living lab research by introducing new *user and stakeholder roles*, and *role patterns*. The study further proposes that *roles decrease the complexity of innovations* and *role-taking leads to predefined roles*. User and stakeholder roles and their role patterns enable understanding and explanations of innovation activities in living labs. Until now, the user and stakeholder roles and their role patterns have been rarely described in the living lab literature. Such studies often refer to roles rather than explaining them. Further, comprehensive descriptions covering a spectrum of user and stakeholder roles and their role patterns in living labs are missing. This study underlines that the user and stakeholder roles and role patterns are one of the crucial contribution of the study.

Identified new user and stakeholder roles

Extant studies on user and stakeholder roles are rare in living labs. This study identified altogether 17 stakeholder roles. Seven completely new roles were identified. These new roles are: *coordinator, builder, messenger, facilitator, orchestrator,* and *integrator*, and one new user role, an *informant*. Ten of the *stakeholder roles* have been previously identified. Prior literature on innovation networks have identified seven roles: *webber, instigator, gatekeeper, advocate, producer, planner*, and a*ccessory*

provider (cf. Gemünden et al., 2007; Heikkinen et al., 2007).

Studies on living labs have referred to three user roles: *tester, contributor*, and *co-creator* in living labs (c.f. Hoving, 2003; Ballon et al.; 2005; Boronowsky et al., 2006a; CoreLabs, 2007; Vérilhac, 2011; Sauer, 2013). Prior studies on living labs focusing on users often offer versatile descriptions of archetypes of users, demographic users groups, and user typologies rather than explicitly addressing and linking activities including creation, prototyping, validating and testing in living labs. This study confirms the existence of the three prior identified user roles and proposes an informant as the new user role in living labs. However, the extant literature is ambiguous in explaining and distinguishing between such user roles. In contrast, this study explicitly explains and distinguishes user roles by coupling activities in living labs.

Similar to the user roles, the stakeholder roles are interesting from the perspectives of open innovation networks and especially living lab networks, because they explain the roles stakeholders have in living lab networks. However, descriptions of stakeholder roles in living labs have been scarce, and the extant studies explain stakeholders and their activities rather than their roles. Extant studies on living labs have offered some loosely defined roles rather than offering a comprehensive description covering a spectrum of user and stakeholder roles in living labs. In contrast, this study offers the typology of 17 explicitly defined stakeholder roles to reveal and understand them in the context of innovation activities in versatile living lab networks. Table 13 gives an overview and characterises the identified roles in living lab networks.

Identified new role patterns

This study identifies and highlights four *role patterns* of living labs: *(1) role ambidexterity, (2) role reciprocity, (3) role temporality and (4) role multiplicity*. Extant studies on living labs are silent on role patterns. Studies on living labs refer to multiple as well as dual and simultaneous activities rather than role patterns in living labs (Kusiak, 2007; Almirall & Wareham, 2009; Arnkil et al., 2010). First, *role ambidexterity* means that actors or stakeholders pursue both role-taking and role-making. In other words, an

actor may take or make their roles in a living lab. The present study proposes that role ambidexterity is a special type of contextual ambidexterity. Gibson and Birkinshaw (2004) found two types of ambidexterity – structural ambidexterity and contextual ambidexterity – in their studies on organisations. Second, *role reciprocity* means that an actor's role leads to the position, and the position leads to a role in living labs. This result is similar to Brass et al. (2005), who found that the relationship between network development and its outcome is reciprocal. Third, *role temporality* describes changes of actors' roles with respect to network changes. Last, *role multiplicity* illustrates the various roles actors have in living labs. Prior studies on open innovation networks identified pluralistic roles of a network hub thus having a role multiplicity (Möller et al., 2005).

Roles decrease complexity of innovations

Stakeholder roles and role patterns document the plurality of living labs but also their innovation activities. Role behavior is more dynamic and unpredictable in living lab networks compared to conventional innovation networks. This finding is opposite to many studies on established networks. This study suggests that predefined stakeholder roles decrease the complex, dynamic and unpredictable nature of living labs and that decreasing complexity leads to predefined incremental innovation outcomes in open innovation networks. This study forms the following two propositions for the future studies of open innovation networks and particularly living labs:

> **Proposition (4):** Predefined stakeholder roles decrease the complexity of innovation activities, where decreasing complexity leads to predefined incremental innovation outcomes in open innovation networks.
>
> **Proposition (5):** Increasing complexity of innovation activities, fostering dynamic and learning between stakeholders, and adapting a broad continuum of roles and role patterns in innovation activities increase the likelihood of an emergence of an undefined and a novel innovation outcome in open innovation networks.

Role-taking leads to predefined roles

This study describes role-taking and role-making in living labs. Role-taking refers to a predefined role; thus, a stakeholder and particularly a user takes its role in the predefined network structures. This means that a role leads to a position and a position leads to a role in living labs. For example, a user being an informant, a tester, and a contributor leads to a node in centralised or decentralised network structures, while being in the node(s) a user acts in the predefined user role. Role-making refers to a stakeholder and a particularly a user making its own role particularly in a multiplex network structure. More specifically, role-making opens a continuum of innovation roles that are not predefined. This study forms two propositions related to role-taking and role-making for future studies of open innovation networks and particularly in living labs:

> **Proposition (6):** Role-taking leads to predefined roles in predefined centralised and decentralised network structures, and being a stakeholder in centralised and decentralised network structures leads to predefined roles in open innovation networks.
>
> **Proposition (7):** Role-making opens up a continuum of roles in a distributed multiple network structure and being a stakeholder in the distributed multiple network structure enables nonpredefined roles in open innovation networks.

7.2.3 Innovation outcomes

This study proposes that *network structures support types of innovations* in living lab networks. This is one of the most crucial contributions of this study. Further, this study proposes that *user roles are coupled to the emergence of innovations* and *confirms innovation categories; types of innovations* and *tangible and intangible innovations*.

Network structures support types of innovations

This study found evidence that the distributed multiple network structure supports the emergence of radical innovations in networks, whereas the two other types of living lab networks – distributed and centralised network structures – promote incremental innovations. However, other aspects

such as actors driving living labs and the objectives of living labs may have been coupled into types of innovations as well. Hence, providers and utilizers align their strategic goals rather than focusing on the emerging, everyday-life problems of users. Therefore, the provider-driven and utilizer-driven living lab networks engender radical innovations. Strategic objectives have been suggested to influence innovation outcomes (Leminen et al., 2012b). The present study argues that the combination of the network structure and the driving actor in the living lab network helps in achieving desired results in living lab networks. More specifically, living labs that are driven by a provider and a utilizer combined with a distributed multiplex network structure and a clearly defined and future-oriented strategic objective enable potential for an emergence of radical innovations. In other words, the distributed multiplex network structure of a living lab, which is driven either by a provider or a utilizer, is most likely to support the emergence of a radical innovation. However, this study did not find any sign that a distributed structure or a centralised structure in innovation activities could lead to radical innovations. Rather, these network structures help significantly in achieving the incremental innovations.

Robertson et al. (2012) note that the open innovation literature mainly focuses on open incremental process innovations. The current study contributes to the discussion on open innovation and especially living lab networks by suggesting that the network structure and driving actors in living lab networks influence desired outcomes in innovation. This study underlines that the suggested successful combination of living lab networks and driving stakeholders do not always lead to radical innovations because of other network- and context-specific factors, but these combinations considerably help to accomplish desired innovation outcomes and results. This study forms four propositions on the relationship between network structures and innovation outcomes for future studies of open innovation networks and particularly living labs:

> **Proposition (8):** A distributed multiple network structure increases the likelihood that a radical innovation will emerge in open innovation networks.

Proposition (9): Distributed and centralised network structures increase the likelihood that an incremental innovation will emerge in open innovation networks.

Proposition (10): Provider-driven and utilizer-driven networks increase likelihood of an emergence of a radical innovation in open innovation networks.

Proposition (11): User-driven and enabler-driven networks increase the likelihood that an incremental innovation will emerge in open innovation networks.

User roles are coupled to the emergence of innovations

The open innovation literature often proposes that internal and external knowledge are fuel for internal and external innovation (cf. Chesbrough & Appleyard, 2007). Customer innovation research in turn emphasises the importance of users in innovation activities (cf. von Hippel, 2007). The present study enlarges the idea of involving users as external knowledge sources for innovation in firms. More specifically, this study explores various different actor roles that influence innovation in networks characterised by openness and user involvement and chooses living labs as the specific research context. This study proposes that the identified four user roles are coupled to the emergence of innovation outcomes in living labs. More specifically, this study documents that a user as a co-creator acts as an active and equivalent partner for developing products, service and systems with other stakeholders in open innovation networks and particularly in living labs. This study proposes that such a user role is coupled to the emergence of a radical innovation, but the study describes such finding implicitly. In contrast, the user roles of an informant, a tester, and a contributor are coupled to the emergence of an incremental innovation, when a user acts as a more passive participant for developing products, service and systems with other stakeholders in open innovation networks and particularly in living labs. This study implicitly describes this finding. To conclude, the study forms two propositions of user roles and their relationship to innovation outcomes for future studies of open innovation networks and particularly living labs:

Proposition (12): A user role of a co-creator increases the likelihood that a radical innovation will emerge in open innovation networks.

Proposition (13): A user role of an informant, a tester, and a contributor increases the likelihood an incremental innovation will emerge in open innovation networks.

Confirmed innovation categories

Prior literature on living labs provides few attempts to categorise innovation outcomes by *types of innovations* and *tangible and intangible innovations* as documented earlier in subchapter 3.3.2. Among the attempts, perhaps the most used categorisation includes incremental and radical innovations but also products and services. The present study included innovation outcomes of both tangible and intangible innovations. The present study referred to the *types of innovations* by their novelty. In accordance with Kusiak (2007) and Svensson and Ihlström Eriksson (2009), the present study typified such innovations as *incremental and radical innovations*. Further, the present study shows tangible and intangible innovations of living labs including *services, products and systems, concepts and product ideas* as well as *knowledge, information and practices*. However, the identified innovation outcomes shown in this study have been found in many earlier studies on living labs as well. Therefore, this study contributes to the literature on living labs by confirming that such 'innovation categories' are useful and applicable when studying living labs rather than introducing new categorisations of innovation outcomes. Appendix 5 briefly concludes the discussion of innovation outcomes in the cases of this study.

7.3 Redefining concepts of innovation mechanisms

This study contributes to the literature on open innovation by introducing new concepts for understanding innovation mechanisms in living lab networks. This study labels them as the *inhalation-dominated and exhalation-dominated innovations*. The current open innovation classifications (Bogers & West, 2010; Dahlander & Gann, 2010; Huizingh, 2011) do not cover the two identified approaches for innovation mechanisms; the present study coins the terms inhalation-dominated and

exhalation-dominated innovations and contributes their definitions to the innovation literature. Further, this study claims that "*the inhalation-dominated innovation approach, or "out-in approach", is initiated and targeted at fulfilling the needs of a driving party by engaging other stakeholders in innovation activities" (*Leminen 2013, 11). Next, this study also claims that *"The exhalation-dominated innovation approach, or "in-out approach", does not primarily fulfil a need of the driving actor, but rather the requirements and wishes of other stakeholders" (*Leminen 2013, 11).

In addition, the present study provides new definitions of *the top-down approach* and *the bottom-up approach* to the literature of living labs in opposition to the prior identified hierarchical types by an authority structure (Weber, 1947) and a parts-within-parts containment structure (Simon, 1962). The present study defines the hierarchy "*as an innovation-facilitation mechanism to facilitate progress towards a given target*" (Leminen, 2013, 8). Consequently, the present study defines "*a top-down approach in living labs as an authoritarian, hierarchical innovation approach that is directed, controlled, and proceeds from top to bottom when creating, prototyping, validating, and testing new technologies, services, products, and systems in real-life contexts" (*Leminen 2013, 8). Last, the present study defines the opposite approach: *"a bottom-up approach in living labs, refers to an innovation approach in which emergent, grassroots ideas and needs are collectively developed, created, prototyped, and validated for mutual and shared objectives, new services, products, systems, and technologies in real-life contexts"* (Leminen 2013, 8). These new definitions are interesting from the perspectives of open innovation networks and especially living lab networks, indicating the pluralistic nature of living labs. In addition, these new definitions further explain innovation activities taking place in a variety of living lab networks.

7.4 Implications for and from the selected research traditions

The subchapter translates the multiple theoretical contributions to the selected research traditions: contingency theory and the resource-based view. It also makes propositions from the research traditions of open

innovation networks and particularly living labs. First, the chapter further highlights the relevance of contingency theory and the resource-based view to studies of living labs and proposes that indirect relationships exist between the research traditions and living labs. Next, it proposes the key implications for contingency theory by the suggested propositions of open innovation networks and suggests propositions from contingency theory for the living lab studies. Further, this chapter discusses the key implications for the resource-based view based on the suggested propositions from open innovation networks, and it also suggests propositions from the resource-based view for future studies of living labs. Last, this chapter concludes the discussion of propositions for future studies in the research traditions.

7.4.1 Connecting the research traditions of contingency theory and the resource-based view with living labs

The extant literature of living labs attempts to review concepts, methodologies, and research streams (Følstad, 2008b; Dutilleul et al., 2010; Fulgencio et al., 2012; Schuurman et al., 2012; Westerlund & Leminen, 2014). However, such studies are rare and concepts related to living labs require further clarification. Further, the literature on living labs often fails to explicitly address its research paradigms or epistemological or ontological backgrounds (cf. Ståhlbröst, 2008; Hakkarainen, 2013; Sauer, 2013; Tang 2014; Schuurman, 2015). The extant studies suggest living labs are a part of open innovation (Bergvall-Kåreborn et al., 2009b; Almirall et al., 2012), but they also attempt to propose some predecessors of living labs, such as co-operative design[74], social experiments[75], and digital cities[76] (Ballon & Schuurman, 2015; Schuurman, 2015). Thus, living lab research can be perceived as being in an early stage. Hence, it is not surprising that the prior literature on living labs fails to couple living labs to the research traditions: contingency theory and the resource-based view. And, how and

[74] Co-operative design refers to the Scandinavian tradition of user involvement including participatory design and user centered design (Schuurman, 2015, p. 126-128)
[75] Social experiments refers to broad variety of field trials in ICT (Schuurman, 2015, p. 132-133)
[76] Digital cities refers to collection and reorganization *"digital information of corresponding cities, and to provide a public information space for people living in/visiting them"* (Ishida et al., 2002, p. 251).

why these research traditions provide an interesting perspective for living labs may be questioned. For example, the resource-based view originates from the strategic question of what types, or combinations, of resources are optimal for obtaining and sustaining competitive advantage in a for-profit, competitive environment, whereas the most living labs are often claimed to be compensated by public funding.

This study proposes that contingency theory and the resource-based view are appropriate for understanding open innovation networks and particularly living labs. Hence, living labs integrate a competitive environment of companies and a non-profit and a public sector (cf. Niitamo et al., 2006). Living labs are often criticised for being subsidised by public funding (Cosgrave et al., 2013). This study proposes that living labs are operationalised in a competitive model, where stakeholders and particularly users are engaged in innovation activities by cost-efficient structures (cf. Veeckman et al., 2013; Rits et al., 2015). More specifically, this study underlines that, in contrast to non-profit organisations or public organisations, living labs rely on commercial models in a competitive environment, and can be argued to be a part of commercial activities, to the extent that the literature on living labs proposes to combine business modelling with living labs (Schaffers et al., 2007; Katzy, 2012, Mastelic et al., 2015, Rits et al., 2015; Salminen et al., 2015). Particularly, a part of living labs are financed by companies and another part develops business models based on selling services, resources, and knowledge.

Further, companies, public organisations, and other non-profit organisations combine resources and develop solutions for societal problems by public-private partnerships (3Ps) or public-private-people partnerships (4Ps) (cf. Kuronen et al., 2010; Stadler, 2012). The organisations are jointly looking for solutions to public problems by a broad variety of models and contingencies (Alford & Hughes, 2008; Stadler, 2012). Even though contingency theory and the resource-based view are not focused on understanding the public and non-profit sectors, these research traditions propose many benefits for understanding complex public-private-people partnerships. Among them, studies analyse contingencies of partnership risks and document risk allocations in public-private partnerships projects through the resource-based view (Jin & Doloi, 2008; Krause, 2014). The private and public organisations share similar logic to

improve the efficiency of their operations (Bryson et al., 2007). These authors show the potential of the resource-based view in the public sector. They identify distinctive competencies and how the competencies are linked with one other. Hence, the research traditions are not only interesting perspectives but are also appropriate for understanding the interplay between private, public and non-profit sectors in public-private-people partnerships, particularly in living labs.

Studies of living labs generally fails to document evidences of direct relationships between the two research traditions and living labs. Even the underlying assumption of situational influences is aligned with contingency theory and living labs. Living labs share situational influence; hence, they are particularly grounded in real-life environments, which differ by their settings and contexts. More specifically, the situational influence makes its appearance by different stakeholders taking and making different roles in different networks structures. The second notable research tradition, the resource-based view, in turn, claims that organisations are dependent on external resources, whereas living labs assume stakeholders bring, share, and develop resources together. The current study did not uncover studies that explicitly couples the research traditions to living labs except Dell´Era and Landoni (2014), who suggests to couple value creation in the living lab technology platform to the resource-based view.

Extant studies suggest implicit relationships between the research traditions and living labs via the open innovation literature. Vanhaverbeke and Cloodt (2014) argue that surprisingly few studies have attempted to integrate and link the existing research tradition of a firm, such as the resource-based view, to open innovation. Among them, studies on contingency theory broaden their perspectives to contingencies (situational factors) in open innovation (Torkkeli et al., 2009), a contingency model of open innovation (Salge et al., 2012), a contingency perspective of open innovation in new product development projects (Bahemia & Squire, 2010), open innovation intermediaries (Agogué et al., 2013) and a contingency model of search openness (Salge et al, 2013). However, the resource-based view includes perspectives for sharing and protecting knowledge coupled to open innovation (Bogers, 2011). Drechsler and Natter (2012) in turn demonstrate that openness in innovation supports a company´s own R&D. Thus, the authors underline a relationship between scarce resources and

openness in innovation. Vanhaverbeke and Cloodt (2014) show that the resource-based view is beneficial for open innovation for a firm to balance internal and external resources.

The literature explicitly couples living labs to open innovation (cf. Lapointe & Guimont, 2015) but also distinct living labs to different forms of open innovation (Almirall and Wareham, 2008b; Bergvall-Kåreborn et al., 2009b). Indirect relationships between the research traditions and the literature of living labs may be identified via the studied concepts or perspectives of this study, including networks, roles, innovation outcomes. More specifically, this study suggests direct relationships between the research traditions and the literature of living labs literature by the propositions related to networks, roles, and innovation outcomes. Next, the study discusses such direct relationships between the research traditions and living labs. Chapter 7.4.2 describes thirteen propositions for contingency theory and two propositions from contingency theory to the literature of living labs. Next, Chapter 7.4.3 reveals fifteen propositions for the resource-based view and two propositions from the resource-based view to the literature on living labs.

7.4.2 Implications for and from contingency theory

From contingency theory to the literature of living labs

The underlying assumption of contingency theory is 'situational influence', where no universal method of organizing business exists, rather it depends on the context and the setting (Ginsberg & Venkatraman, 1985). Living labs share situational influence; hence, they are particularly grounded in real-life environments, which differ by their settings and contexts. In contrast, contingency theory focuses on an organisation, a company or its subunits, where both internal and external constraints reveal situational influence (Hickson et al., 1971; Ginsberg & Venkatram, 1985). Hickson et al. (1971) underline that contingencies, for example uncertainty, ensue where alternatives and outcomes of future are unpredictable. Many studies on living labs illuminate loosely coupled constellations of a broad variety of stakeholders and organisations. Ginsberg and Venkatram (1985) cover strategic contingencies and contingency variables including environmental, organisational, and performance variables. Studies on contingency theory

frequently address the impacts of variables on a chosen strategy. This study proposes that strategic contingencies and contingency variables, and particularly strategies and their variables, are interesting and relevant topic that enrich the studies of living labs. Hence innovation strategy is a less explored area in studies of living labs (Leminen & Westerlund, 2014). This study proposes its first proposition from contingency theory to the literature of open innovation networks and particularly living labs and describes it as the fourteenth overall proposition, as follows.

> **Proposition (14):** Strategic contingencies and contingency variables strengthen the understanding of a uniqueness of innovation activities, and how innovation activities are coupled to innovation strategies in living labs.

A living lab is not a type of managed and controlled organisational form as meant in prior studies on contingency theory. Hickson et al. (1971) claim that an organisation is a system of interdependent subunits where they have division of labour. In contrast, the present study underlines that living labs cover a broad variety of network structures often characterizing loosely coupled constellations of innovation activities. Contingency theory proposes that organisations often function in diverse and contradictionary contingencies where there are debates on relations between the contingencies (Drazin & Van de Ven, 1985). In particular, multiple and conflicting environmental contingencies are interesting from living lab perspectives. Hence, a living lab underlines a real-life environment and its stakeholders, where a broad range of stakeholders, often labelled as providers, utilizers, enablers and users, bring their expertise and knowledge to living labs. This study proposes that the diverse and contradictory contingencies are interesting and relevant topics that enrich studies of living labs. Thus, paradoxical tension fosters an emergence of innovations (Leminen et al., 2015c). Diverse and contradictory contingencies are less-explored areas in studies of living labs, particularly how different stakeholders perceives different the innovation activities and their relationship to the real-life environment (Leminen & Westerlund, 2014). This study proposes its second proposition from contingency theory to the literature of open innovation networks and particularly living labs, and presents it as the fifteenth proposition for living labs:

Proposition (15): Diverse and contradictory contingencies of a real-life environment increase the likelihood that innovation activities will be strenthened and that an innovation outcome will emerge in open innovation networks.

From living labs (results of this study) to contingency theory

Kok and Biemans (2009) explored how an industrial firm creates a market orientation innovation process, which depends on environmental innovation and organisational context. Gopalakrishnan and Damanpour (1994) in turn identified two opposite streams of innovation development models in contingency theory. The former unitary sequence pattern is grounded on a linear sequence innovation process, where phases follow each other, and their breakpoints are identifiable. The latter multiple-sequence pattern claims that innovations take place as complex, messy and parallel activities, where the number of stages or their existence is unpredictable. In this vein, Häusler et al. (1994) claim that innovations are increasingly interactive and circular rather than linear activities, where joint and predefined goals are difficult to set, particularly for non-routine tasks and beyond incremental improvements in a collaborative research project. *The present study shares the view of the difficulties on predefined, fixed plans, phases and goals*, where they are 'changing' during innovation activities. In contrast to Häusler et al. (1994), where the authors underline that a premise of difficulties is to control staff members, which are involved in collaboration between organisations. This study in turn proposes that *undefined and latent user needs in real-life environments support changing plans of innovation activities, and adjusting innovation activities.*

Many prior studies of conventional innovation management ground on an assumption to predefine a target(s) of innovation activity and set up measurable phases. Deviations are monitored and corrective actions are set up for the deviations from predefined aims. In contrast to the conventional innovation model, this study proposes that an absence of strict objectives pursue on non-predefined innovation outcomes in living labs. Given the absence of strict objectives, living labs adapt to flexibly acquire resources

for innovation activities in order to change direction(s) of innovation activities. Further, this study proposes that the absence of strict objectives speeds up innovation activities in open innovation networks, particularly in living labs. Stakeholders and users share knowledge, resources, and experiences and learning between them and from the real-life environments, which have otherwise been difficult or time consuming to identify during predefined innovation activities in laboratory settings. This study highlights that collaboration and outcomes are achieved in the absence of strict objectives in innovation networks. In accordance with the propositions (1)-(3)[77] for open innovation networks and particularly for living labs, this study suggests them for contingency theory.

Contingency theory frequently discusses exploration to external markets, whereas living labs take another stance and share their knowledge to trusted networks, as documented in this study. Tsai (2009) shows relationships between collaborative networks and product innovation performance. Torkkeli et al. (2009) in turn document a situational influence of internal and external constraints, where companies explore or exploit knowledge and resources in open innovation networks. The present study broadens understanding of situational influence in open innovation network, particularly in living labs. In accordance with the classification of network structures by Barabasi (2002), *the present study confirms that centralised, decentralised or distributed networks exist in living labs*. The classification of network structures in living labs is interesting from contingency theory perspectives because such a categorisation exists per se but *different living lab networks also represent different settings and contexts where living labs exist*. More specifically, situational influences on networks exist in living labs, where network structures support types of innovations in living lab networks. This study proposes that the distributed

[77] **Propositions (1)-(3)** to contingency theory:

Proposition (1): An open innovation network seeks a novel and an unforeseen innovation outcome by not setting strict objectives for innovation outcomes.

Proposition (2): An open innovation network attempts to accelerate innovation activities by sharing the knowledge, resources, and experiences and learnings across stakeholders and users and from real-life environments.

Proposition (3): An absence of a strict objective increases the need to flexibly acquire new knowledge and resources for the innovation activities in open innovation networks.

multiple network structure supports the emergence of radical innovations in networks. The two other types of living lab networks, distributed and centralised network structures, promote incremental innovations.

In other words, this study underlines that *contextual and situational needs illuminate networks structure and driving party, which support desired outcomes in innovation networks*. This study suggests four propositions for future studies of contingency theory in accordance with propositions (8)-(11)[78]. This is the important implication and it is contrast to many studies on contingency theory. More specifically, providers and utilizers align their strategic goals rather than focusing on the emerging, everyday-life problems of users. Hence, the provider-driven and utilizer-driven living lab networks engender radical innovations. In contrast, enabler and utilizer living labs support an emergence of incremental innovations. Hence, this study explains relationships between network structure, innovation mechanism (driving party), and innovation outcomes rather than explaining how internal and external constraints such as the size and the organisational structure affect organisational performance. Contextual and situational needs illuminate networks structure and driving party, which support an emergence desired outcomes in innovation networks.

Prior studies on contingency theory discuss user, team or human resource practices in relation to innovation outcomes[79] (cf. Edstrom, 1977; De Dreu, 2006; Slappendel, 2006; Beugelsdijk, 2008; Dong et al., 2014). Given a view where living labs are characterised by interlinked innovation activities

[78] **Propositions (8)-(11)** to contingency theory:

Proposition (8): A distributed multiple network structure increases the likelihood that a radical innovation will emerge in open innovation networks.

Proposition (9): Distributed and centralised network structures increase the likelihood that an incremental innovation will emerge in open innovation networks.

Proposition (10): Provider-driven and utilizer-driven networks increase likelihood of an emergence of a radical innovation in open innovation networks.

Proposition (11): User-driven and enabler-driven networks increase the likelihood that an incremental innovation will emerge in open innovation networks.

[79] Such studies include both types of innovations: tangible and intangible.

of stakeholders, the present study broadens studies on contingencies to different user and stakeholder roles in living lab networks, in contrast to work roles in organisations (Drazin & Van de Ven, 1985). The present study concludes a broad variety of stakeholder roles, which covers altogether 17 roles in innovation activities of living lab networks. The roles are important as they articulate different roles stakeholder may take or have. Role-taking implies predefined roles; thus, a stakeholder, and particularly a user, takes the role in the predefined network structures. This means that a role leads to a position and a position leads to a role in living labs. More specifically, this study suggests that a user being an informant, a tester, and a contributor leads to a node in centralised or decentralised network structures; while being in the node(s) a user acts in the predefined user role. Role-making refers to a stakeholder, and a particularly a user, making their own role, particularly in a distributed multiplex network structure. More specifically, role-making opens up a continuum of innovation roles, which are not predefined. This study proposes that role-taking and role-making support understanding of contingencies. More specific, he study suggests two propositions for the future studies of contingency theory in accordance with propositions (6)-(7)[80] for the literature of open innovation networks and particularly living labs.

This study claims that user and stakeholder roles support understanding of contingencies in innovation networks. Identified roles enrich understanding of innovation activities and such roles as resources support understanding of divergent innovation activities in open innovation networks. This study suggests two propositions related to the relationships between roles and innovation outcomes for future studies of contingency theory in accordance with propositions (12)-(13)[81].This study proposes that

[80] **Propositions (6)-(7)** to contingency theory:
Proposition (6): Role-taking leads to predefined roles in predefined centralised and decentralised network structures, and being a stakeholder in centralised and decentralised network structures leads to predefined roles in open innovation networks.
Proposition (7): Role-making opens up a continuum of roles in a distributed multiple network structure and being a stakeholder in the distributed multiple network structure enables nonpredefined roles in open innovation networks.

[81] **Propositions (12)-(13)** to contingency theory:
Proposition (12): A user role of a co-creator increases the likelihood that a radical innovation will emerge in open innovation networks.

a user as a co-creator acts as an active and equivalent partner for developing products, services and systems with other stakeholders in open innovation networks and particularly in living labs. This study proposes that such user roles are coupled to an emergence of a radical innovation. A user, as an informant, a tester, and a contributor acts as a more passive participant for developing products, services and systems with other stakeholders in open innovation networks and particularly in living labs, and such user roles are coupled to an emergence of incremental innovation.

In addition to roles, this study suggests two role patterns for contingency theory: role temporality and role reciprocity. Such role patterns show role behaviour in innovation networks where role temporality describes changes of actors' roles in response to network changes. Role reciprocity in turn reflects the contextual change of networks from roles to positions and vice versa. Stakeholder roles and role patterns document the plurality of living labs but also its innovation activities. Role behaviour is more dynamic and unpredictable in living lab networks compared to conventional innovation networks. This study suggests to understanding the complexity, dynamic and unpredictable nature of living labs by predefining stakeholder roles and decreasing of complexity, leadings to predefined innovation outcomes in open innovation networks. This study claims that *role patterns support understanding of contingencies* in innovation networks, where the identified role patterns enrich understanding of innovation activities and such roles as resources support understanding of divergent innovation activities in innovation networks, particularly in open innovation networks. This study proposes that the relationship between roles and role pattern and innovation outcomes can be examined with two propositions for future studies of contingency theory in accordance with propositions (4)-(5)[82] for the literature of open innovation networks and particularly living labs.

Proposition (13): A user role of an informant, a tester, and a contributor increases the likelihood an incremental innovation will emerge in open innovation networks.

[82] **Propositions (4)-(5)** for contingency theory:

Proposition (4): Predefined stakeholder roles decrease the complexity of innovation activities, where decreasing complexity leads to predefined incremental innovation outcomes in open innovation networks.

Proposition (5): Increasing complexity of innovation activities, fostering dynamic and learning between stakeholders, and adapting a broad continuum of roles and role patterns in innovation activities increase the

Last but not least, this study proposes that different settings and contexts in living labs explain innovation mechanisms from contingency theory perspectives. As far as the researcher knows, the extant studies of contingency theory do not articulate inhalation-dominated and exhalation-dominated innovation approaches per se. In particular, inhalation-dominated and exhalation-dominated innovation approaches articulates to whom living labs target their innovations. Hence, the inhalation-dominated innovation approach articulates to whom innovation activities are targeted and initiated for the purpose of a driving party in an innovation network. In contrast, the exhalation-dominated innovation approach aims to fulfil requirements and wishes of other stakeholders rather than a primarily need of a driving actor in a network. This study claims that *inhalation-dominated and exhalation-dominated innovation approaches explain 'situational influence' of innovation activities in innovation networks.*

7.4.3 Implications for and from the resource-based view

From the resource-based view to the literature of living labs

The scholarly literature frequently debates the resource-based view and its interlinkages with other approaches (cf. Conner, 1991; Mahoney & Pandian, 1992; Barney et al., 2001; Briem & Butler, 2001; Mahoney, 2001; Barney et al., 2011). Living labs are grounded on an assumption of a broad variety of stakeholders combining their resources, where stakeholders bring, share and develop them together (Eriksson et al., 2005; Schaffers & Kulkki, 2007; Westerlund & Leminen, 2011). The resource-based view articulates that resources are a source of competitive advantage to a firm and are drivers of performance (Conner, 1991), where heterogeneous and immobile resources sustain a company's competitive advantage (Barney, 1991). Barney (1991) includes a broad variety of assets, capabilities, organisation processes, firm attributes, information and knowledge in the resources of a firm. Wernerfelt (1984) underlines that predefined resources are antecedents of products, where resource barriers prohibit competitors to enter and compete in markets. Such resources are valuable, rare, imperfectly imitable and not substitutable (Barney, 1991; Barney et al., 2001). By the same token, Peteraf (1993) suggests that a firm's competitive advantage includes

likelihood of an emergence of an undefined and a novel innovation outcome in open innovation networks.

superior resources, limited competition and resource immobility. Amit and Schoemaker (1993) explicitly include rivals, customers and rivals to strategic industry factors affecting its assets. Taken together, the prior resource-based view, labelled as the '1991 view' by Fiol (2001), often emphasises that a single firm controls and owns resources (Dyer & Singth, 1998; Fiol, 2001).

In contrast, the '2001 view' incorporates the contextualised behaviour of a firm (Fiol, 2001). For example, Lavie (2006) underlines that it is not necessary for a firm to own resources but it must control them. Dyer and Singth (1998) in turn claim that a pair or networks of firms can create relationships that can result in competitive advantage. Lavie (2006) distinguishes firms as independent entities from interconnected firms. She explains that resources beyond organisational boundaries broaden the competitive advantage of a firm, whereas Bogers (2011) focuses on R&D collaboration between organisations from a single-firm perspective. The present study suggests that living labs assume collaboration between stakeholders that have both individual and common goals. In contrast to contexts where resources are controlled and owned by a firm, this study underlines that living labs include divergent innovation mechanism. This study proposes that the widely agreed perspective of valuable, rare, imperfectly imitable and not substitutable resources can be applied the literature of living labs as well. This study, among the many studies of living labs, proposes in an almost unanimous way that all stakeholders share their knowledge and resources. The extant living lab studies attempt to illuminate such resources and knowledge rather than valuating them for innovating activities. Living labs can be seen as an intermediaries (Almirall & Wareham, 2011) or platforms (Habib et al., 2015) where stakeholders exchange and share resources with others. Dell´Era and Landoni (2014) propose that value creation in the living lab technology platform can be coupled to the resource-based view. Such exchanging and sharing of resources target to fulfill the shared aims of stakeholders in living labs. More specifically, this study suggests that the literature on living labs benefits understanding of the most valuable resources. This study proposes the sixteenth proposition for the literature of open innovation networks and particularly living labs:

Proposition (16): An open innovation network strengthens the potential for an emergence of a novel innovation outcome, when stakeholders share and develop rare and invaluable resources beneficial for innovation outcomes.

The resource-based view often documents intraorganisational and interorganisational networks and their linkages (cf. Gulati et al., 2000; Tsai, 2000) and articulates different network structures such as local and structural networks (Black & Boal, 1994), alliance networks (cf. Lavie, 2006), collaborative networks (cf. Arya & Lin, 2007) and business networks (cf. Nyström, 2008). The researcher is not aware of studies that distinct the network structures by Barabasi (2002) in the resource-based view[83]; rather, the resource-based view explains network structures by many concepts including centrality[84] and density[85] in networks (cf. Gnyawali & Madhavan, 2001). Such concepts may help to conceptualise living lab networks but also to understand and explain the current stage of the network and how living labs networks are evolving. This study proposes that an understanding of the density of a network increases understanding of innovation activities but also their emergence in open innovation networks. For example, Gnyawali and Madhavan (2001) propose that high-density networks increase the flow of information and resources between actors in a network; thus, there is less competition between actors. In accordance with those authors, this study suggests the seventeenth proposition for the literature of open innovation networks and particularly living labs as follows:

Proposition (17): Increasing density of a network increases the flow of information and other resources between stakeholders in open innovation networks.

[83] Among network studies, Smedlund (2008) applies probably one of the most used distinctions of network structures by Barabasi (2002). Smedlund (2008) claims that diverse knowledge resources relate to appropriate network structures in the knowledge-based view.
[84] Centrality refers to the "*position of an individual actor in the network*" (Gnyawali & Madhavan, 2001, p. 434).
[85] Density refers to the "*extent of interconnection among the actors of the network*" (Gnyawali & Madhavan, 2001, p. 438).

Nyström (2008) in turn distinguishes industrial networks by the ARA (actor, activity and resource) model. She considers actor, activity and resources as crucial parts in networks. The present study confirms that *conceptualisations of networks and actor, activity and resource perspectives exist and are useful in living labs.* Studies on the research-based view incorporate employees, teams and managers in product development (cf. Henderson, 1994; Grant 1996b).

From literature of living labs to the resource-based view

This study proposes that *open innovation networks support divergent innovation mechanisms rather than contexts where resources are owned or controlled by a firm.* In other words, the resource-based view claims that organizations are dependent on external resources owned or controlled by them. In contrast to purchasing a rare resource from markets (Drechsler and Natter, 2012), living labs assume stakeholders bring, share, and develop resources together. More specifically, this study proposes that companies may benefit from living labs as a source of external resources, where the companies may utilise such sources by jointly developing resources but also having access to other organizations' knowledge and resources. Thus, an organization may develop their resources in open innovation networks and particularly living labs, where organizations commonly share and develop their resources with other stakeholders. This study proposes its first proposition from the literature of living labs for future studies of resource-based view as follows:

> **Proposition (18):** An open innovation network enables a company to access valuable, rare and imperfectly imitable resources and develop them with other stakeholders; such resources are otherwise unattainable in a restricted boundary of innovation activities controlled by a company.

New definitions on innovation mechanisms, particularly the inhalation-dominated and exhalation-dominated innovation approaches developed in this study, are interesting for the resource-based view. As far as the researcher knows, the inhalation-dominated and exhalation-dominated

innovation approaches are not articulated per se in prior studies of the resource-based view. Hence, the inhalation-dominated innovation approach articulates the underlying assumption of the resource-based view, where innovation activities are targeted and initiated for the purpose of a driving party in an innovation network. In contrast, the exhalation-dominated innovation approach aims to fulfil requirements and wishes of other stakeholders rather than a primarily need of a driving actor in a network. Sirmon et al. (2007) address structuring the resource portfolio, bundling resources and leveraging them to market opportunities. Sirmon et al. (2011a, b) in turn articulate resource orchestration. The main body of such studies on the resource-based view focus on stakeholders beyond the organisational boundary of a firm or partners a firm can control. In contrast with such studies, the present study underlines that stakeholders of living labs are facilitated rather than controlled; thus, stakeholders of living labs exist beyond the organisational boundaries of a single firm. The finding is interesting for the resource-based view, because innovation activities increasingly take place beyond organisational boundaries of companies. The boundary beyond a company represents a more complex innovation environment than a restricted boundary monitored or controlled by a single company. Hence, innovation activities should be facilitated rather than managed in open innovation networks (Westerlund & Leminen, 2011). This study proposes its second proposition from the literature of living labs for the resource-based view as follows:

> **Proposition (19):** An organisation improves its innovation activities by seeking to facilitate them beyond their organisational boundaries rather than controlling such activities in open innovation networks.

From living labs (results of this study) to the resource-based view

In accordance with Brown and Eisenhardt (1995)[86], Verona (1999) claims that a variety of agents beyond an organisational boundary, including senior management, project teams and the project leader, affect the

[86] Brown and Eisenhardt (1995) are ambiguous in their theoretical underpinnings; thus, they cover normative empirical studies of product development. The authors implicitly intimate the resource-based view.

effectiveness of product development. In particular, such studies include activities undertaken by managers. For example, Rao and Drazin (2002) emphasise that talent recruitment overcomes a lack of managerial resources in product development. The literature on living labs frequently includes divergent stakeholders such as providers, utilizers, users, and enablers (cf. Ballon et al., 2005; Leminen et al., 2012a) and in contrast to the extant studies on the resource-based view, living labs are driven by different stakeholders rather than a firm per se (cf. Leminen et al., 2012a). Thus, governance of innovation activities changes when a company participates in innovation activities that they do not own, control, or steer. This study proposes relationships between network structures and innovation outcomes in living labs. More specifically, a distributed multiple network structure supports the emergence of radical innovations in networks, whereas the two other types of living lab networks – distributed and centralised network structures – promote incremental innovations. Further, providers and utilizers align their strategic goals rather than focusing on the emerging, everyday-life problems of users. Therefore, the provider-driven and utilizer-driven living lab networks engender radical innovations. Meanwhile, user-driven and enabler-driven living labs support an emergence of incremental innovations. This study suggests four propositions for future studies of the resource-based view in accordance with propositions (8)-(11)[87] for the literature of open innovation networks and particularly living labs:

There are scattered studies on roles in the resource-based view. For example, Tushman and Katz (1980) explain the gatekeepers' influence on

[87] **Propositions (8)-(11)** for the resource-based view:

Proposition (8): A distributed multiple network structure increases the likelihood that a radical innovation will emerge in open innovation networks.

Proposition (9): Distributed and centralised network structures increase the likelihood that an incremental innovation will emerge in open innovation networks.

Proposition (10): Provider-driven and utilizer-driven networks increase likelihood of an emergence of a radical innovation in open innovation networks.

Proposition (11): User-driven and enabler-driven networks increase the likelihood that an incremental innovation will emerge in open innovation networks.

the project performance in R&D settings[88], where gatekeepers act as a link between organisations and external environments. Brown and Eisenhardt (1997) identify a futurist as an additional managerial role. According to them, a futurist focuses on long-term aspects of product innovations. Verona (1999) also underlines the impacts of gatekeepers and lead users on innovation performance. Gulati et al. (2000) articulate a network structure, a network membership and a modality as resources. Although they do not explicitly document stakeholder roles in networks, they do discuss concepts nearly related to roles. For example, a network member includes a variety of stakeholders in a network. Modality explains how a firm creates and maintains its network resources. Menguc et al. (2014) document that customer and supplier involvement impacts new product performance. Similar to Gulati et al. (2000), the present study confirms a variety of stakeholders in networks and proposes to broaden the focus from employees of a company to a variety of stakeholders in networks. Acknowledging the critique of the resource-based view on managerial-related processes and actions (Kraaijenbrink et al., 2010), the role of managers requires further development. Nyström (2008) documents change processes in business networks by role-taking and role-making. She focused on change process of business networks focusing on the collective roles of companies. The present study in turn suggests to enrich the resource-based view by the identified 17 roles and four role patterns for all stakeholders in an open innovation network well, where this study interprets roles as resources. More specific, this study underlines that *roles as resources support understanding of divergent innovation activities in innovation networks*. This is interesting from the perspective of the resource-based view; thus, divergent stakeholder roles are coupled with the activities in living labs. Stakeholders contribute innovation activities in living labs by providing facilities and premises, or users express their latent needs, wishes and participate in a variety of innovation activities.

The study suggests the two propositions for the future studies of the resource-based view in accordance with propositions (6)-(7)[89] for the

[88] Even Tushman and Katz (1980) do not position themselves to the resource-based view; rather, they are ambiguous in their theoretical underpinnings.

[89] **Propositions (6)–(7)** for the resource-based view:

Proposition (6): Role-taking leads to predefined roles in predefined centralised and decentralised network structures, and being a stakeholder

literature of open innovation networks and particularly living labs. More specific, a user being an informant, a tester, and a contributor leads to a node in centralised or decentralised network structures; while being in the node(s), a user acts in the predefined user role. Role-making occurs when a stakeholder, and a particularly a user, makes their own role, particularly in a distributed multiplex network structure. In other words, role-making opens a continuum of innovation roles that are not predefined.

This study proposes that user roles are coupled with the emergence of innovation outcomes. More specifically, this study proposes that a co-creator role is coupled to an emergence of a radical innovation. In contrast, a user as an informant, a tester, and a contributor acts as a more passive participant for developing products, services and systems with other stakeholders in open innovation networks and particularly in living labs. Such user roles are coupled to an emergence of an incremental innovation. The study suggests two propositions for future studies of the resource-based view in accordance with propositions (12)-(13)[90] for the literature of open innovation networks and particularly living labs.

Roles patterns are interesting from the perspective of the resource-based view. Hence, role ambidexterity claims that stakeholders may take or make roles in living labs. More specifically, role ambidexterity enables further understanding of how products and services are developed in different contexts of living lab networks. In addition, role multiplicity underlines that stakeholders may have multiple roles that influence the functioning of innovation activities in living labs. Identified role patterns enrich understanding of innovation activities and such roles as resources support understanding of divergent innovation activities in open innovation networks. This study suggests that the predefined stakeholder roles

in centralised and decentralised network structures leads to predefined roles in open innovation networks.

Proposition (7): Role-making opens up a continuum of roles in a distributed multiple network structure and being a stakeholder in the distributed multiple network structure enables nonpredefined roles in open innovation networks.

[90] **Propositions (12)-(13)** for the resource-based view:

Proposition (12): A user role of a co-creator increases the likelihood that a radical innovation will emerge in open innovation networks.

Proposition (13): A user role of an informant, a tester, and a contributor increases the likelihood an incremental innovation will emerge in open innovation networks.

decrease complexity of innovation activities and such decreasing of complexity leads to a predefined innovation outcome(s) in innovation networks. This study suggests two propositions for future studies of resource-based view in accordance with propositions (4)-(5)[91] for the literature of open innovation networks and particularly living labs as follows: increase the likelihood of an emergence of an undefined and a novel innovation outcome in open innovation networks.

The resource-based view offers numerous studies on performance (cf. Arya & Lin, 2007; Crook et al., 2008; Calantone et al., 2010; Fang et al., 2011; Ngo & O'Cass, 2012; Menguc et al., 2013). Among the studies, Crook et al. (2008) emphasise that there are ongoing debates and inconsistences in resource-related performance in prior studies of the resource-based view. In their meta-analysis study on strategic resources and performance, they found a strong relation between them. In contrast to their performance measures such as market share and sales growth, this study proposes that resources and knowledge in a variety of networks support the emergence of desired innovation outcomes; thus, this study underlines that network structures support types of innovations in living labs.

The resource-based view is inconsistent in protecting and sharing resources, where the prior studies explicate them as sources of the competitive advantage (cf. Wernerfelt, 1984; Barney, 1991). The latter, opposite view underlines that interorganisational collaboration is grounded on sharing resources between organisations (cf. Bogers, 2011). He focuses on tensions between these conflicting views. The present study shares the latter view by underlining that living labs are grounded on close collaboration, where a stakeholder shares resources and knowledge with other parties in a network. Further, the origin of the resource-based view is grounded in 'linear thinking', where predefined resources are linked to products (Wernerfelt, 1984). Vanhawerbeke and Cloodt (2014) underline that an open innovation funnel aims to reduce uncertainties in an early

[91] **Proposition (4)-(5)** for the resource-based view:
Proposition (4): Predefined stakeholder roles decrease the complexity of innovation activities, where decreasing complexity leads to predefined incremental innovation outcomes in open innovation networks.
Proposition (5): Increasing complexity of innovation activities, fostering dynamic and learning between stakeholders, and adapting a broad continuum of roles and role patterns in innovation activities

innovation process. The present study takes another stance and argues that shared resources and skills in prior conducted innovation activities support the emergence of later unforeseen innovation activities and outcomes.

Shared resources and skills in prior conducted innovation activities support the emergence of later unforeseen innovation activities and outcomes. Many prior studies of conventional innovation management ground on an assumption to predefine a target(s) of innovation activity and set up measurable phases. In such cases, deviations are monitored and corrective actions are set up for the deviations of predefined aims. In contrast to the conventional innovation model, this study suggests three propositions for future studies of the research-based view in accordance with propositions (1)-(3)[92] for the literature of open innovation networks and particularly living labs. More specific, this study proposes that an absence of strict objectives avoids predefined innovation outcomes in living labs. Given the absence of strict objectives, living labs adapt to flexibly acquire resources for their innovation activities in order to change direction(s) of innovation activities. Further, the absence of strict objectives speeds up innovation activities in open innovation networks, particularly in living labs. Hence, stakeholders and users share knowledge, resources, and experiences and learning between them and from the real-life environments, which have otherwise been difficult or time consuming to identify during predefined innovation activities in laboratory settings.

As described above, the study introduces propositions for the resource-based view. Given that the resource-based view is the widely accepted and used research tradition in organisational studies, the resource-based view offers many promising and relevant topics for the literature on living labs.

[92] **Proposition (1)-(3)** for the resource-based view:

Proposition (1): An open innovation network seeks a novel and an unforeseen innovation outcome by not setting strict objectives for innovation outcomes.

Proposition (2): An open innovation network attempts to accelerate innovation activities by sharing the knowledge, resources, and experiences and learnings across stakeholders and users and from real-life environments.

Proposition (3): An absence of a strict objective increases the need to flexibly acquire new knowledge and resources for the innovation activities in open innovation networks.

Among them, this study identifies the two propositions for future research on open innovation networks, particularly living labs.

7.4.4 Propositions for and from the research traditions

The study has suggested many propositions related to networks, roles and innovation outcomes but also interdependences between them, for the literature on contingency theory and the resource-based view. The study suggests that such propositions may be tested and evaluated in future studies of contingency theory and the resource-based view

Propositions for and from contingency theory

This study claims that open innovation networks and particularly living labs reveal many interesting perspectives for understanding situational influence in contingency theory. Such perspectives include networks structures, stakeholder roles, and innovation outcomes and innovation mechanisms and formed to the propositions. More specific this study proposes the propositions (1)-(13) for contingency theory based on the results of this study. In addition, this study suggests two propositions, the propositions (14)-(15), from contingency theory for the literature of open innovation networks and particularly living labs.

Propositions for and from the resource-based view

This study claims that living labs reveal many interesting perspectives for the resource-based view. Such perspectives include *network structures, stakeholder roles, innovation outcomes and innovation mechanisms*. More specific this study proposes the propositions (1)-(13) for the resource-based view based on the results of this study. In addition two additional propositions, the propositions (18)-(19) are drawn from the literature of living labs for the resource-based view. Last, this study suggests the propositions (16)-(17) from the resource-based view for the literature of open innovation networks and particularly living labs.

7.5 Managerial implications

For the purpose of this study, a variety of frameworks, models, concepts and tools were developed in the articles. With these tools and frameworks,

it is possible to identify and categorise open innovation networks and pursue innovation development in open innovation networks, especially in living lab networks. This study underlines that the *developed multiple frameworks and tools support the identification and categorisation of open innovation networks and pursue innovation development in open innovation networks,* especially in living lab networks. This study proposes that the developed tools and frameworks in this study are useful in a wider context of open innovation networks. These tools include *a matrix of innovation mechanisms in living lab networks, a framework for analysing the configuration modes of living lab networks, the user role path towards becoming a creative consumer,* and the *roles and role sets as a tool for innovations*. Further on, this study provides new typologies and concepts for business managers but also other practitioners involved in open innovation networks. More specifically, this study articulates the meanings of versatile living lab networks and also grasps the meaning of participation in living labs. The study also provides a foundation for governance mechanisms in living labs.

A matrix of innovation mechanisms in living lab networks

This study proposes that the framework, a matrix of innovation mechanisms (Figure 11) in living lab networks, could be used to identify and analyse a variety of living lab approaches to pursue innovation development with them. More specifically, the suggested framework enables managers and practitioners to create further understanding of innovation mechanisms in living labs by positioning their organisations' innovation activities. For example, this means that by adopting a top-down approach, an organisation limits its options either to exhalation-dominated or inhalation-dominated approaches. A provider is driving innovation activities in an exhalation-dominated innovation approach or a utilizer, and an organisation itself is driving innovation activities. Whereas, by adopting bottom-up approach, an organisation focuses either to exhalation-dominated driven by an enabler or inhalation-dominated approaches, which is a user-driven living lab.

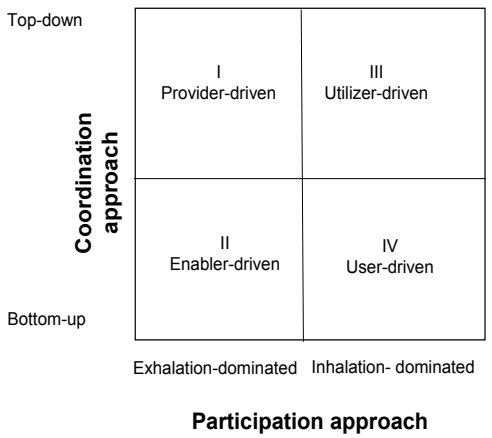

Figure 10. A matrix of innovation mechanisms in living lab networks (Leminen 2013, 11)

The developed framework is beneficial to managers because it enables their organisations to develop innovations in a spectrum of coordination and participation approaches in various open innovation networks. Thus the framework couples such approaches Furthermore, the present study integrates to four previously identified types of living lab networks (Leminen et al., 2012a) into the framework to identify and analyse innovation activities but options organisations have in open innovation networks.

A framework for analysing the configuration modes of living lab networks

This study proposes a conceptual framework for analysing the configuration modes of living lab networks (Figure 12). This framework can be used to categorise, identify and analyse structures and organisations as well as to pursue innovation development and the outcomes of innovations in diverse living lab networks. Thus, the framework reveals the typologies and concepts of living labs for managers and clarifies reasons for organisations to participate in open innovation networks, especially in living labs. In addition, the framework provides a means to arrange network governance towards potential and desired outcomes in living lab networks. The configuration models of living labs are interesting for managers and practitioners; thus, the framework offers a broad variety of alternatives of

living lab networks for companies and other organisations. As explained earlier, network structures support types of innovations, where the study suggested that the network structure and driving actors influence the desired outcomes in innovation.

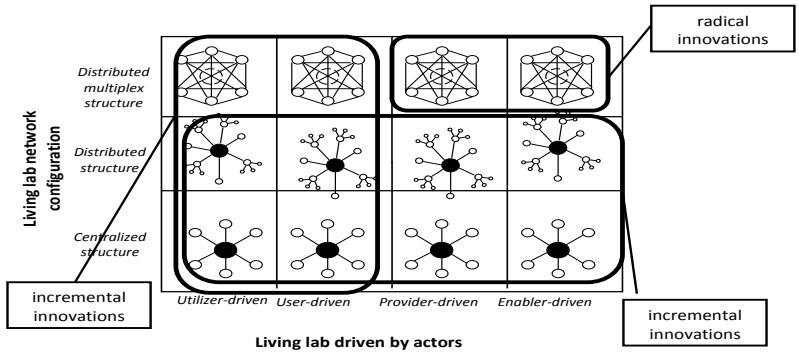

Figure 11. A framework for analysing the configuration modes of living lab networks (modified from Leminen et al., 2015a)

More specifically, this study suggested that managers wishing to target a radical innovation in open innovation networks should select the distributed multiple network structure. Distributed and centralised open innovation network structures promote an emergence of incremental innovation in open innovation networks. Beside the network structure, managers should pay attention to the stakeholder driving the networks, because provider-driven and utilizer-driven living labs enable an emergence of a radical innovation in open innovation networks. User-driven and enabler-driven living labs support an emergence of an incremental innovation in open innovation networks.

User role path towards becoming a creative consumer

This study introduces the user role path in becoming a creative consumer (Figure 13). The user role path integrates the dimensions of the degree of user activity ("high" versus "low") and a firm´s view of co-creation ("user as a subject" versus "user as an object") when approaching creative consumers. The introduced framework enables managers to diagnose the type of user involvement managers wish to engage in their organisations'

innovation activities. Organisations may find ways to inspire users along a spectrum of user activity and firm´s view of co-creation.

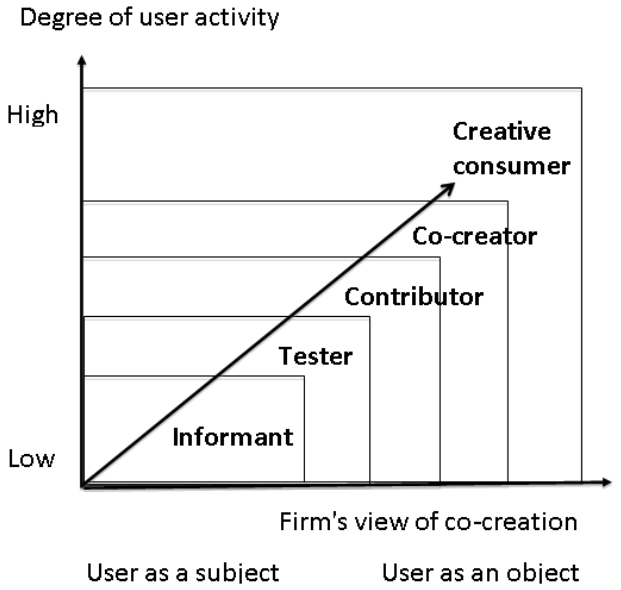

Figure 12. The user role path towards becoming a creative consumer (Leminen et al. 2014a, 5)

The user path and the four user roles are particularly interesting for managers and practitioners. Hence, two fundamental different options exist for a firm's view of co-creation: a user may act as a subject or an object of a study. Such views limit the options that companies and other organisations may have with users in living labs. In other words, a high degree of a user activity is coupled to co-creator and/or contributor roles rather than users having roles of informant and/or tester. More specifically, this study proposed that a user role of a co-creator supports an emergence of a radical innovation in open innovation networks. In contrast, this study also proposed that a user role of an informant, a tester, and a contributor supports an emergence of an incremental innovation in open innovation networks.

Roles and role sets as a tool for innovations

This study also proposes that managers and practitioners can see open innovation activities and the relationships of different stakeholder in a new light with the help of roles and role sets. All actors may review stakeholder roles and positions in networks; thus, a company can organise its innovation goals and activities to meet the desired roles and positions of stakeholders in innovation networks. In other words, roles and role sets are particularly interesting for managers and practitioners. Hence, this study proposed that a manager may decrease the complexity of innovation activities by predefining roles of stakeholders and role patterns in innovation activities in an open innovation network. Thus, such roles and role sets include a broad variety of options that companies and other organisation have in living labs when such organisations participate in innovation activities. Such roles provide reveal options: the organisation may take or make their roles with other stakeholders in living labs. More specifically, decreasing the complexity of open innovation networks pursue on a predefined innovation outcome(s) (incremental innovations) in innovation networks; thus, stakeholders are taking their roles. In contrast, this study proposed that an open innovation network increases the emergence of undefined and novel innovation outcomes by increasing the complexity of innovation activities, by fostering dynamics and learning between stakeholders, and by adapting a broad continuum of roles and role patterns in innovation activities. This study suggests the identified roles and role sets as a starting point when developing innovation activities with a broad variety of stakeholders in different contexts.

7.6 Doubts and critiques for living labs

Many studies raise doubts and critiques for living labs by different means (Table 17). First, studies raise many doubts and critiques for *concepts and methods*, *innovation and outcomes*, and *legal issues*.

Doubts and critiques for methods and concepts

The literature on living labs raises many doubts and critiques on methods and concepts. For example, Wilson et al. (2008) claim that researchers on living labs are *not familiar with related concepts* because of their

backgrounds and experience. The authors underline that they do not criticise the underlying concept or philosophy of living labs per se. The present study does not agree with the critique that researchers are 'not familiar with related concepts', given that many scholars and researchers on living labs differentiate living labs from other forms of open innovation (cf. Bergvall-Kåreborn et al. 2009b; Almirall et al., 2012), other R&D and development approaches (cf. Eriksson et al., 2005; Pallot et al., 2010; Almirall et al., 2012), and test and experimentation platforms (cf. Ballon et al., 2005).

Wilson et al. (2008) continue that *the term 'living lab' is used in a diffused manner*. The present study, among the numerous studies on living labs, shares this critique. This study gives an overview of different terms including living lab, living laboratory and living labbing and concludes that studies on living labs use these terms reciprocally although there are slight differences between them, as documented earlier in this study. Extant studies on living labs cover many disciplines and such studies apply and share many ideas and concepts from different disciplines. This study underlines that researchers on living labs are not necessarily familiar with concepts and ideas borrowed from other disciplines such as the concept of 'roles' and 'networks'.

The literature on living labs addresses an additional critique for concepts: living labs are often addressed as a diffusion of a *fuzzy and ill-defined concept* (Almirall & Wareham, 2009). The present study shares the critique because prior literature on living labs provides numerous definitions for living labs and in many cases such studies are ambiguous in conceptualising living labs. This study claims that the literature on living labs lacks an overview on characterisations of living labs and particularly research streams of living labs. Therefore, this study offers a comprehensive discussion on characteristics and constructs of living labs by providing a systematic literature review of living labs. The literature review results in identifying constructs of living labs and three meanings of living labs as represented by the three research streams on living labs: 'a living lab as a context', 'a living lab as a methodology', and 'a living lab as a conceptualisation'. Living labs have been documented to consist of *a variety of concepts instead of a single concept* (Leminen et al., 2012a). Such

variety is grounded on the assumption that living labs are used in many contexts by different means to solve or support innovation development activities. There are *needs for new models and tools in living labs* (Budweg et al., 2011). The present study fully shares the view and argues the need for developing new models and tools for understanding living labs and innovation activities. Therefore, this study proposes many new models and tools for understanding living labs and innovation activities. This study also attempts to conceptualise living labs from the perspectives of networks, roles, and innovation outcomes. Thus, the study offers further conceptualisations and designs for studies on living labs.

The literature on living labs addresses an additional critique of 'a living lab as a method'. Wilson et al. (2008) argue that *a living lab is merely a tool* among many others for research rather than "a panacea". The authors continue on referring to living labs as a methodology. The present study does not share the critique because many studies on living labs position living labs against other methodologies (cf. Almirall et al., 2012). Such studies explicitly document living labs as a continuum of innovation methodologies. Numerous studies document living labs in many contexts, and researchers and scholars of many disciplines apply living labs for a broad variety of purposes. Given the three identified streams on living labs in this study, the study claims that living labs are beyond methodologies and offer many benefits for versatile stakeholders. Many studies on living labs address *a need for a more systematic analysis of their applicability* for development and experimentation in different contexts and situations (Feurstein et al., 2008; Shamsi, 2008; Schaffers et al., 2009). The present study shares the critique that there are scattered studies covering multiple contexts and situations. Typically, studies on living labs are single case studies conducted in an isolated context (cf. Kipp & Schellhammer, 2008; Schuurman et al, 2010a; Schuurman et al, 2010b). However, studies including multiple contexts (Budweg et al., 2011) or multi-case studies (cf. Arnkil et al., 2010; Almirall & Wareham, 2011; Coetzee et al., 2012; Veeckman et al., 2013; Sauer, 2013) have not received much attention as a source for further conceptualisations of living labs.

Doubts and critiques for innovation activities and outcomes

The literature on living labs raises many doubts and critiques on innovation activities and outcomes in living labs. More specifically, living labs often focus more on the business aspects than the development aspects, living labs trials are costly, there are difficulties in engaging and motivating users and stakeholders, and innovation outcomes are not 'preseen'. For example, Wilson et al. (2008) claim that *living labs often focus more on business than development aspects*. The present study does not share the critique given that prior studies on living labs often document a broad variety of benefits to a variety of stakeholders rather than merely focusing on the benefits to business (see Appendix 1). Further, this study underlines that living labs differ by innovation mechanism and their activities. Such innovation activities are targeted to a broad variety of stakeholders rather than focusing on business.

Living lab trials are perceived as costly (cf. Molinari, 2008; Wilson et al., 2008) because innovation activities often require facilitation of users. The facilitation in turn requires resources even though users often participate in the activities based on their own interests (Westerlund & Leminen, 2011). The present study shares the views that costly resources are needed in living labs. However, according to Zaltman (2003), a significant number of new product and service launches fail to reach market even when customer analysis has been conducted. Therefore, the present study underlines that it is preferable to focus on innovation activities in living labs than to experiment with the needs of artefacts including products, services and systems during their launches into markets. Studies on living labs often highlight *difficulties in engaging and motivating users and all stakeholders* in innovation development (cf. Kviselius et al., 2009; Schaffers et al., 2009; Dutilleul et al., 2010). Dutilleul et al. (2010) address the arbitration of different needs of stakeholders in living lab networks. The present study partly shares these views: it is often proposed that company interests steer living labs (cf. Niitamo et al., 2012). However, a range of other types of living labs exist (cf. Leminen et al., 2012a), which promise not to engage and motivate users but collaborate with all stakeholders and foster innovation activities based on all their needs. Particularly, this study underlines that innovation mechanisms of living labs include different

participation and coordination approaches, where the means of engaging and motivating users differ. Among then, the bottom-up innovation approach assumes that innovation activities are grounded in the needs of users and citizens. Therefore, in many cases, users and stakeholders do not need motivation for innovation activities in living labs because of their own interests (cf. Hess & Ogonowski, 2010; Ståhlbröst & Bergvall-Kåreborn, 2011). Westerlund and Leminen (2011) propose that *results or innovation outcomes are difficult to estimate in advance* (Westerlund & Leminen, 2011). Such claims underline that living labs often rely on an iterative approach rather than a conventional, linear innovation model. The present study shares their view, where the premises of innovation activities in living labs often end up linked to results not seen in advance (cf. Westerlund & Leminen, 2011).

Doubts and critiques for legal issues

Studies on living labs raise many doubts and critiques in relation relating to *legal issues* including *privacy and data protection* (Pitkänen, 2008), *intellectual property rights* (Eriksson et al. 2005; Pitkänen, 2008), *contractual and consumer protection* (Pitkänen, 2008), as well as *international and cross-border issues* (Pitkänen, 2008). The premise of such studies is often grounded on assumptions that innovation activities and outputs of innovations are steered and protected by contracts. The present study takes another perspective and addresses that innovation activities are often directed by a variety of stakeholders such as users, academia, companies and other organisations, and different stakeholders are encouraged to use the results of those activities rather than protecting the innovation output for only users.

This study partially shares the doubts and critiques as discussed above. The study underlines that there are many challenges to applying living labs in organisations; thus, organisations are required to change their existing mindsets of innovation. More specifically, living labs increasingly support engagement of many stakeholders, emphasise importance of users in innovation activities in real-life environments and guide collaboration with emerged and developed objectives rather than sticking to predefined plans on innovation activities within organisational boundaries.

Table 17. Doubts and critiques for living labs

Clusters of doubts and critiques for living labs	Doubts and critiques for living labs	Source
Concepts and methods	Familiarity with related concepts	Wilson et al. 2008
	The term 'living lab' is used in a diffused manner	Wilson et al. 2008
	Fuzzy and ill-defined concept	Almirall & Wareham 2009
	A variety of concepts instead of a single concept	Leminen et al. 2012a
	Needs for new models and tools	Budweg et al. 2011
	Not "a panacea" but merely a tool	Wilson et al. 2008
	Applicability for development and experimentation in different contexts and situations	Feurstein et al. 2008; Shampsi 2008; Schaffers et al. 2009
Innovation activities and outcomes	Focus more on business rather than development aspects	Wilson et al. 2008
	Costly living lab trials	Molinari 2008; Wilson et al. 2008
	Engagement and motivation of users and stakeholders	Kviselius et al. 2009; Schaffers et al. 2009; Dutilleul et al. 2010
	Innovation outcomes not "preseen"	Westerlund & Leminen 2011
Legal issues	Intellectual property rights	Eriksson et al. 2005; Pitkänen, 2008
	Privacy and data protection	Pitkänen 2008
	Contractual and consumer protection	Pitkänen 2008
	International and cross-border issues	Pitkänen 2008

7.7 Evaluation of the study

Relevance of the study

The positivistic and hermeneutic research traditions are grounded on different assumptions and goals (cf. Hirschman, 1986; Hudson & Ozanne, 1988). Such traditions use different terminologies and criteria (Hirschman, 1986). Studies suggest a set of different criteria for evaluating the relevance of the research (cf. Lincoln & Guba, 1985; Gummesson, 1991; Yin, 2003). Among them, Gummesson (1991) suggests nine quality criteria for

qualitative research: *own conclusions, paradigm, credibility, adequate access, validity of research, contribution, dynamic research process* and *commitment and integrity*. Each of the criteria covers a set of sub-quality criteria. Lincoln and Guba (1985) include *credibility*, *transferability, dependability* and *conformability* in a set of criteria for hermeneutic research. In accordance with Lincoln and Guba (1985), this dissertation employs these criteria to evaluate the relevance of this research. Table 18 summarises the relevance of the present study by the means for assuring criteria of hermeneutic research.

Table 18. Relevance of the research

Criteria	Overview of criteria	Means for assuring criteria
Credibility	Research portrays multiple realities, which represent those constructs that are credible (Lincoln & Guba, 1985).	The cases reveal living labs from a variety of perspectives such as networks, stakeholders and their roles, and innovation outcomes. The integrative framework of living labs developed in this study summarises these perspectives. Different living labs and a variety of their interviewed representatives on different levels and roles provides a multiple source of evidence in living labs.
Transferability	Other researchers judge the transferability of findings to other contexts (Lincoln & Guba, 1985).	Results are applicable in different constructs of living labs; thus, cases represent a variety of living labs along a living labs continuum covering different contexts and representing findings across cases and across informants.
Dependability	Reliability reveals a temporal stability and internal consistency of "measurements" (Lincoln & Guba, 1985).	The data is drawn from different living labs using the open theme interview protocol(s). The interview protocols were developed and pretested by some living lab representatives during case studies. Multiple observations are included; thus, the interviews were conducted and analysed by multiple researchers.
Conformability	Research establishes an audit trail and an audit process (Lincoln & Guba, 1985).	The interviews are documented either by recorded interviews and field notes and memos in those interviews. The research and its results are presented in the published articles but also in conferences, workshops, seminars and unofficial discussions. The researchers and managers are enabled to judge the interpretation and follow analysis from gathered data, especially in the published articles.

Credibility

Lincoln and Guba (1985) argue that research should sufficiently portray multiple realities and credible constructs on those multiple realities. Therefore, the present study reveals a variety of perspectives of multiple stakeholders as documented in Article 1 as a single case study. The other articles reveal the living lab cases across multiple living labs cases from a variety of perspectives including networks, stakeholders and their roles, and innovation outcomes. This study assures for the informants that no personal information or case information are included so that informants are able to freely address their knowledge and experiences on living labs; otherwise, informants may misrepresent their beliefs, as documented by Hirschman (1986). In accordance with Yin (2003), the present study applies one embedded and a single case design as well as embedded and multi-case designs for the analysis of a multiple sources of evidence in living labs by interviewing a variety of representatives on different levels and roles in living labs and including a different living labs. In addition to those interviews, the researcher has gained experiences of working in living labs, and multiple informal discussions on living labs were held as well.

Transferability

Lincoln and Guba (1985) argue that the hermeneutic research provides the data and findings, while other researchers make the judgements for the transferability of findings to other contexts. Yin (2003) suggests that external validity refers to generalisations of findings in qualitative research, which necessitates further replications of findings. Hirschman (1986) in turn proposes that no contexts are similar; thus, transferability includes interpretations between contexts. Therefore, transferability depends on other researchers' and practitioners' knowledge and experience of living labs. It may be argued that the findings are case specific. However, this study proposes that the results are applicable in different constructs of living labs; thus, the cases represent a variety of living labs in a living labs continuum covering different contexts and representing findings across cases and informants in different countries.

Dependability

Lincoln and Guba (1985) address that reliability reveals a temporal stability and an internal consistency of "measurements", which includes interviews of human beings. Yin (2003) in turn proposes that the construct validity operationalises measurements and is often problematic in case studies. Therefore, a researcher should demonstrate that measurements reflect a phenomenon to be studied. The open theme research questions on living labs are grounded on understanding living labs in this study. Miles and Huberman (1994) explain that research should be consistent enough over time and across researchers and methods. The present study used the open theme interview protocol to draw the data from different living labs. In accordance with Silverman (1993), the present study 'pretested' the interview protocol and interview questions through pre-understanding interviews and then in a larger scale, also during the first single case study as documented in Article 4, in order to avoid misunderstanding of research questions. Further, this study includes multiple observation; thus, the interviews were conducted and analysed by multiple researchers, as shown in the articles.

C*onfirmability*

According to Hirschman (1986), a hermeneutic researcher is not neutral to studied phenomenon but is rather deeply involved in understanding and often having personal interests for the studied phenomenon. Next, Yin (2003) proposes that reliability refers to conducting another case study in similar way by diminishing errors and bias in a qualitative research. Further, Lincoln and Guba (1985) address that research establishes an audit trail and audit process for conformability. Therefore, the interviews were documented by recording them and field notes and memos were taken in those interviews. Hirschman (1986) proposes that the researcher being familiar with the phenomena would benefit from other interpretations. Therefore, the research and its results were presented in the published articles but also in conferences, workshops, seminars and unofficial discussions. Further, the co-authored articles are joint efforts of the

multiple researchers: vivid discussions of interpretations of the data occurred during the preparation of these co-authored articles. Last but not least, researchers and managers are enabled to judge the interpretation of this study and follow the research process from data gathering to the findings and results of this study.

Limitations

All studies have their limitations. There are several limitations in this study as well. First, this study did not focus on technology platforms or a variety of technologies utilised in living labs; even technology platforms and technologies are often embedded in living lab contexts as a part of living lab approaches (Intille et al., 2005; Fahy & Ponce de Leon, 2008; Broens et al., 2009). Next, the present study did not include technologies or technology embedded products, services and systems, even when they were often developed, validated and tested to acquire user experiences in living lab contexts (Intille et al., 2005; Deryckere et al., 2008; Ferm et al., 2009, Tang et al., 2010). Further, the present study did not intend to expose used methodologies in living labs, even though methodologies are often embedded in the living labs phases (cf. Schumacher & Feurstein, 2007; Schaffers & Kulkki, 2007; Budweg et al., 2011). Rather the present study differentiated a living lab from the other R&D and development approaches.

This study was based on the dataset collected during the period from 2008-2011 from 26 living labs in four different countries: Finland, Sweden, Spain and South Africa. The largest number of living lab cases in this study are from Finland, a country that has a large number and variety of living labs. This focus might bias the dataset. However, the living lab cases were comparable to each other when studying living lab networks, and such a bias was not seen during this study. Although the data set was extensive and consists of altogether more than 100 interviews, the data was collected from multiple numbers of actors covering different stakeholders in multiple living labs. The data collection covered the limited period of living labs. Thus, during a short period, only a limited number and types of actors and living labs could be covered for the data collection. However, living labs are more systematic way of innovations rather than being a single project or a

limited time span (Westerlund & Leminen, 2011). Thus, living labs are often characterised as iterative, where a set of initiatives follows initiatives (Schuurman et al., 2011).

The highlighted finding, "collaboration and outcomes in living labs are achieved in the absence of strict objectives", were explicitly documented in one extensive case study including 7 organisations and the group of users covering altogether 20 informants. However, the finding was discovered in other cases as well, for example #7, and #20 in Paper 3 but not explicitly documented in other articles.

Even though the study positions itself in relation to contingency theory and the resource-based view, such research traditions were not the starting point of the dissertation. In contrast, the study first focused on conducting the articles. Besides writing the articles, the study conducted the systematic literature review of living labs for the articles and Part 1. The literature review identified different research streams of living labs. However, the literature review did not show much explicit evidence on living labs as a part of larger research traditions of organisational studies. Acknowledging such the gap in literature living labs, the study later positioned it in relation to contingency theory and the resource-based view because of the parallels underlying the research traditions and living labs. The study made the coupling to the research traditions based on the results and contributions of the study rather than taking the research traditions for the starting point of this study. This study acknowledges that innovations, contingency theory, and the resource-based views are discussed in a broad variety of research in many disciplines. Hence, hardly any research could simultaneously tackle the plurality of all aspects or even all their relevant aspects. Given this plurality, this study attempts to describe some relevant categorisations on innovations but also to partially grasp such notable theories.

7.8 Future research on living labs

Given these limitations, this study proposes extensive longitudinal, cross-case and cross-country analysis to increase further understanding of the characteristics of open innovation networks and particularly the living lab networks, while acknowledging that longitudinal studies on living labs are

rare (cf. Lievens et al. 2010; Schwartz et al., 2013; Ogonowski et al., 2013). The analysis could cover themes network structures and their actor, activity and resource perspectives in living labs, stakeholder roles, and types of innovations as well as innovation outcomes. The present study proposes the following key future research topics and questions in living lab networks.

1) A living lab network by definition consists of a multiple different stakeholders, which are actors undertaking various activities in a constantly transforming network. Possible new network configurations of actors, activities and resources may lead to identifying new stakeholder roles and role patterns. This may have an influence on the identified actor roles and role patterns and strategizing stakeholder roles. Thus, a new research question can be formulated as:

    - *What are the influences of new network configurations on possible stakeholder roles and role patterns?*

2) User and stakeholder roles may evolve in different projects following each other in the same living labs. A research question can be formulated as:

    - *How are user and stakeholder roles evolving across different projects in same living labs?*

3) Living lab networks may vary in network constellations between the extremes of a handful of stakeholders involved or engaged in innovation activities (e.g. Leminen & Westerlund, 2012) versus thousands of participants as documented in Schuurman and De Marez (2009). Thus, infrastructures and characteristics may vary in living lab networks, and there might be differences between a small number of stakeholders and possibly biased other participants. The present study focused on understanding actors rather than relationships between them. The relationship and its development between different stakeholders requires more attention in living lab networks but also in other types of open innovation networks. Perhaps social network analysis (cf. Scott, 2013) might provide a

tool to analyse interactions, relations, attributes and dynamics in open innovation networks, particularly in living labs. A research question can be described as:

- *What are the relationships and how do relationship patterns of different stakeholders evolve in living lab networks and other open innovation networks?*

4) It would also be important to study whether a driving actor can be changed in consecutive cases in the same living labs. If such changes take place, a research question can be articulated as:

   - *How do the changes of a driving actor affect coordination and participation approaches to innovation?*

5) Surprisingly, innovations and innovation outcomes are only marginally covered in living lab networks. In contrast to conventional networks, open living lab networks frequently address a multiplicity of stakeholders but offer scattered studies explicitly on the classification of innovations. A research question can be formulated as:
   - *What are future classifications of innovation outcomes in living labs particularly from the perspectives of multiple stakeholders?*
   - *How can prior classifications on innovation from different disciplines to living lab networks be incorporated?*

6) The conventional innovation management view frequently proposes that predefined objectives of innovation activities and their dividable and measurable sub-goals form the core of innovation activities and that, by eliminating them, innovating activities may be enhanced. In contrast, this study claims that collaboration and outcomes in living labs are achieved in the absence of strict objectives. To verify the finding in innovation networks and to understand more about mechanism of such innovation activates in

innovation networks and particularly open innovation networks such as living labs a research question can be formulated as:

- *What are innovation mechanisms that support the absence of strict objectives in innovation networks?*

7) Network management is still only marginally covered, even in conventional networks. In opposition to conventional networks, open innovation networks increase openness and make management or even orchestration a more perplexing task. A research question can be formulated as:

- *How are different open innovation networks managed or facilitated, particularly living lab networks?*

Finally yet importantly, the earlier suggested future research topics are mainly based on further understanding living labs from empirical points of view, thereby providing new vital material for understanding living labs. The study has suggested many contributions and results of networks, roles and innovation outcomes but also interdependencies between them. This study argues that there is a need for further conceptualisations of living labs but there is also a need to test and evaluate the suggested seventeen propositions as a first step toward 'a theory of living labs'. The current study suggests that such propositions of open innovation networks and particularly living labs may be tested and evaluated in future studies of contingency theory and the resource-based view as well. The traditions should be understood as complementary ones to understand a pluralism of living labs rather than alternatives in a continuum of living lab studies. Further, the current study argues that living labs are the tip of the iceberg in an emerging and paradoxical change of innovations. Therefore, it is vital to utilise and the adoption of ideas from other notable traditions or theories of organisational studies multiple theoretical perspectives to questioning existing assumptions of conventional innovation approach when conducting research on living labs. Research questions can be formulated as:

- *How do theories of organisational studies support further understanding of living labs?*
- *What are paths to a theory of living labs?*
- *What is a theory of living labs?*

To conclude, the present study provides many conceptualisations, tools, and topics of future studies for scholars and researchers but also managers and practitioners of living labs. Given that living labs are frequently applied in a broad range of fields and sectors, the literature on living labs also crosses many disciplines and expertise. Therefore, the study does not only underline but also warmly encourages future studies validating results on existing studies and examining untouched and fascinating areas of living labs, which are particularly grounded in the propositions of this study for networks, roles and innovation outcomes in living labs. Overall, research on living labs provides many opportunities for researchers and scholars.

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APPENDIXES:

Appendix 1. Benefits and opportunities of living labs

Numerous studies on living labs propose that a living lab is a prominent and an emerging form of open innovation (cf. Almirall & Wareham, 2008b; Bergvall-Kåreborn et al., 2009b). Studies on living labs often describe multiple benefits and opportunities for exploring and exploiting living labs as a part of companies and other organization's activities. For example, Mirijamdotter et al. (2006) argue that innovation activities are moving from laboratories to real life. That transformation provides a variety of benefits for various stakeholders such as academia (university and research centre), industry, citizens, users, and public and private organizations utilizing, funding and following activities in living labs. Intille et al. (2006) address that a living laboratory provides an environment in which the richness of complex user behaviour may be studied. Mulder et al. (2008) in turn propose that users tend to react differently in a real-life situation than in a laboratory environment. Thus, living labs provide multiple benefits for users and user communities but for other stakeholders as well (The European Commission, 2009). The European Commission (2009) report emphasises that an empowered influence of users lead savings and improved R&D processes. Benefits to SMEs include improved activities from developing to scaling up to products and services to markets. Key benefits to larger companies address a 'right the first time' characteristic, thus making their innovation processes more effective. Living labs foster stakeholder partnership and increase returns of innovations for an economy and a society. Almirall and Wareham (2009) find that living labs reduce market-based risks by enabling an arena for iterative experimenting, "try it, and fix it". Bendavid and Cassivi (2012) continue that living labs are especially applicable for exploring unpredictable and unstructured contexts. Thus, complex, multidisciplinary, multi-method, and multi-culturally aspects are often included in living labs (Fulgencio et al., 2012). To sum up, living labs have been proposed to benefit innovating activities in many ways, where this study categorises the proposed benefits and opportunities of living labs in four clusters and labels them as *enhancing innovation by new means, benefiting contexts i.e. real-life environments, improving business activities* and *opening new business opportunities,* as shown in Table A.1.

Table A.1. Benefits and opportunities for living labs

Clusters of benefits and opportunities	Benefits and opportunities	Source
Enhancing innovation by new means	Enhance learning	Bajgier et al. 1991; Abowd 1999
	Tackle complex real-life problems	Bajgier et al. 1991; Mulder 2008
	Foster vertical integration	Eriksson et al. 2005
	Enhance dialogue between different stakeholders	Schaffers & Kulkki 2007
	Share experiences	Schaffers & Kulkki 2007
	Enhance SME´s incubation	Van Rensburg et al. 2007
	Filter problems	Schuurman & Marez 2009
	Open collaboration between actors	Bergvall-Kåreborn et al. 2009b
	Enhance multi-organizational collaboration	Kviselius et al. 2009
	Use as focal point for multi-organisational collaboration	Kviselius et al. 2009
	Engage all key actors for innovation	Mulder & Stappers 2009
	Understand innovation	Mulder & Stappers 2009
	Enable unique knowledge	Dutilleul et al. 2010
	Access real interaction data and real application contexts	Azzopardi & Balog 2011
	Motivate users	Ståhlbröst & Bergvall-Kåreborn 2011
	Enhance sustainable solution development	Liedtke et al. 2012
Benefiting contexts i.e. real-life environments	Use in different contexts	Eriksson et al. 2005
	Provide an environment to study richness of complex user behaviour and use of technology in home	Intille et al. 2005, 2006
	Integrate multicontextual sphere i.e. regional and cultural diversity	Feurstein et al. 2008
	Catalyse rural and regional systems of innovation	Schaffers & Kulkki 2007
	Integrate fundamental and applied research	Mulder and Stappers 2009
	Empower rural communities in developing countries	Mutanga et al. 2011
	Advance Smart City operations	Ballon et al. 2011
	Upscale urban development	Ballon et al. 2011
	Provide assets for innovation environment	Schaffers et al. 2011

	Explore unpredictable and unstructured contexts.	Bendavid and Cassivi, 2012
Improving business activities	Reduce cost by sharing infrastructures	Ponce de Leon et al. 2006
	Ensure market evaluation	Mirijamdotter et al. 2006
	Share resources such as technologies, know-how, collaboration tools	Schaffers & Kulkki 2007
	Reduce market-based risks	Almirall & Wareham 2009
	Integrate resources	Schaffers et al. 2009
	Deploy customised products	Feurstein et al. 2008
	Reduce technology and business risk	Mirijamdotter et al. 2006; Pallot et al. 2010
	Lead savings and improved R&D processes	European Commission 2009
	Make innovation process more effective	Ståhlbröst 2006; European Commission 2009; Mulder & Stappers 2009
	Improve activities from developing to scaling up to product and services to markets	European Commission 2009
	Strengthen innovation capacity	Bergvall-Kåreborn et al. 2009b
	Proof of innovation in contexts	Mulder & Stappers 2009
	Improve take-up ratio of patents	Mavridis et al. 2009
	Affecting supply chains	Wamba 2012
Opening new business opportunities	Localise products	Feurstein et al. 2008
	Open new business opportunities	Kviselius et al. 2009
	Lead to unexpected market opportunities	Mavridis et al. 2009

Appendix 2. Versatile meanings and interpretations of living labs

Construct	Characteristics of Construct	Definition of construct	Source
Living laboratory	- Experiment environment - Human	As elements and conditions of a body and an environment of an experiment	Knight 1749
Living laboratory	- User responses to TV commercials - Citizen as user	As a way to study users' responses to tv commercials in their living rooms by making phone-call to the users	The Billboard weekly magazine 1956
Living laboratory	- Real-world needs gathered from the city neighbourhood - Multistakeholder - Restricted area, city neighbourhood - Iterative - New model - Students as users	As a restricted city neighbourhood to enhance student learning in solving real-world problems with other stakeholders	Bajgier et al. 1991
Living laboratory	- Industrial plant - Multistakeholder - Own employee	As a mechanism for developing and implementing public involvement in nuclear safety	Bengtson 1994
Living laboratory	- Real-life setting - Ubiquitous computing environment - Restricted place - Users as developers - Students and teachers as users	As a restricted place, a classroom for capturing, teaching and learning experiences by ubiquitous computing	Abowd 1999
Living laboratory	- Home prototype - Computational environment - Initial occupants, students - Controlled experiment	As an authentic but experimental setting, a computational environment to interpret and understand the home	Kidd et al. 1999
Living laboratory	- Real-world situation (temporary project in Zoo Atlanta) - User - Activities for complex problems	As a concept to *"analyze a complex problem and exercise component skills in a real-world situation, p. 2-78"*.	Benne & Fisk 2000
Living laboratory	- Real-life environment - "A home" - Demonstrating technology - Studying interaction - Evaluating usage of technology for human behaviour	As a real-life environment to demonstrate building technology with embedded technology, studying physical-digital interaction in home and evaluating the meaning of pervasive computing for human behaviour in the home	Intille 2002

Living laboratory	- Real-life setting with embedded sensors - Data gathering - Limited time period - Users - A volunteer as a resident of an apartment	As a real-life lab-like setting to gather data from users' behavioural use of technology with help of sensors and formal protocols	Intille et al. 2005; Intille et al. 2006
Living laboratory	- Multi-role and multi-faceted involvement of the customers	As a living innovation laboratory, pursued innovation results, which are co-created from information, data and knowledge as well as resources collected from different stakeholders and the environment	Kusiak 2007
Living lab	- Citizens to be monitored by epidemiologists	As a country for testing the connection between diet, lifestyle factors and disease	Moffat 1990
Living lab	- Testing new materials and construction methods	As a concept house for evaluating new materials and construction methods by researchers	Tarricone 1990
Living lab	- Development project - Employees as users in user groups - Multilevel co-operation (executive and operation level)	As a development project in a vendor–customer relationship to provide information and test prototypes by own employees	Lasher et al. 1991
Living lab/living laboratory	- Approach to real world - Scaled simulations - Team members - Outcomes	As *"an approach to integrate theory and practice, continuous process improvement, and tool development in collaborative system research". (p. 209)*	McNeese et al. 1999
Living lab/living laboratory	- Concept - Holistic approach - Socio-technical system design - Team members - Outcome	In accordance with McNeese et al. 1999	McNeese et al. 2000
Living lab	- Building - Experimental platform - Experimenting technologies - Not a project - Temporary residence - Differentiate from traditional lab setting	As a building that provides an experimental platform for home-related technologies with temporary residence	Markopoulos & Rauterberg 2000
Living lab	- Real life - Users as co-producer - Uncontrollable dynamics - Elderly, immigrants and people as a target group	*As "a setting that is created with specific targets and has a clear structure, but in the same time is dealing with the uncontrollable dynamics of daily life". (p. 4)*	Hoving 2003

	- Researcher intervenes in innovation activities		
Living lab	- Innovation system - Real-world contexts (real users and use situations) - Openness - Public involvement - Commercial maturity - Vertical scope - Scale - Duration	As "*an experimentation environment in which technology is given shape in real-life contexts and in which (end) users are considered 'co-producers'". (p. 5)*	Ballon et al. 2005
Living lab	- Real-life environment - Multistakeholder approach: users, public, firms and academia - Multicontextual - User as innovator	As a R&D methodology to create and validate in collaborative multicontextual empirical real-world environment, users central role of innovator	Eriksson, Niitamo & Kulkki 2005
Living lab	- Meta-methodology - Phases (contextualisation, concretisation, implementation and feedback) - Cyclic	As "*facilities for designing, developing, testing and evaluating communication technologies and services in early stages of the innovation process by involving (early) users.*" (p. 115)	Pierson & Lievens 2005
Living lab	- Access to technology - Agglomerate organisation using technology - Agglomerate public interest - Broad co-operation with citizen	As *"an emerging Public Private Partnership (PPP) concept in which firms, public authorities and citizens work together to create, prototype, validate and test new services, businesses, markets and technologies in real-life contexts, such as cities, city regions, rural areas and collaborative virtual networks between public and private players." (p. 1)*	Niitamo et al. 2006
Living lab	- R&D methodology - User-centred real-life approach - Collaborative multi-contextual environments - Design, test, validate and develop - Co-creation by real consumer and end users (e-environment) - Living lab network	*"As an R&D methodology where innovations, such as new services, products or applications enhancements, are created and validated in collaborative multi-contextual empirical real-world environments within individual regions." (p. 1)*	Ponce de Leon et al. 2006
Living lab	- Stakeholders - Human-centric - Iterative approach - Contexts - Real-life environments	As *a "support innovation processes among businesses and local and central authorities by offering human-centric evaluation of innovations in a real-world use environment, in abstract." (p. X)*	Ståhlbröst 2006

Living lab	- System - Innovation process - Users as contributors and co-creators - Five key principles on living labs, continuity, openness, realism, empowerment of users and spontaneity	As *"a system enabling people, users/buyers of services and products, to take active roles as contributors and co-creators in the research, development and innovation process." (p. 9)*	CoreLabs 2007
Living labs	- Part of wider innovation system - Multistakeholder - Public-private partnership - Phases	*"As a systemic instrument for innovation, ...as instruments for networked innovation, ... as public-private partnership, ... Phased development of Living Labs-" (p. 2)*	Fahy et al. 2007
Living lab	- Classroom - Children active participants - Multiple technologies	As a "*challenge of examining new technologies in everyday contexts as used by people according to their own goals." (p. 2)*	Lacasa et al. 2007
Living lab	- Experimentation and validation environments - User centric - Catalyse rural and regional systems of innovations - Cooperation between users, technology and application	*"As experimentation and validation environments characterized by early involvement of user communities, closely working together with developers and other stakeholders, and driving rapid cycles of ICT- based innovations." (p. 31)*	Schaffers & Kulkki 2007
Living lab	- User involvement - Innovation arena - Innovation intermediary	*"As intermediaries in the innovation process, structuring and providing governance to that participation." (p. 24)*	Almirall & Wareham 2008a
Living lab	- Networked approach - Phased product and service development process	As "*collaborations of public-private-partnerships in which stakeholders co-create new products, services, businesses and technologies in real-life environments and virtual networks in multicontextual spheres." (p. 2)*	Feurstein et al. 2008
Living lab	- Important role of user - Evaluation and validation of ICT solution - Unexpected ICT use and new service opportunities - Experimentation in familiar context of users - Medium- and long-term user studies	As *"a range of environments or approaches to ICT innovation and development." (p. 49)*	Følstad 2008a
Living lab	- Part of innovation and development process - Realistic context	*As "environments for innovation and development where users are exposed to new ICT solutions in (semi)realistic contexts, as part of medium- or long-*	Følstad 2008b

	- User involvement - New solutions	*term studies targeting evaluation of new ICT solutions and discovery of innovation opportunities." (p. 116)*	
Living lab	- Importance of user - Regional innovation system - Methods - Public sector development	As an *"opportunity to study the importance of users in regional innovation systems and develop methods to integrate users into the public sector development." (p. 5)*	Konsti-Laakso et al. 2008
Living lab	- Stakeholders - Support open innovation - Delivering results for needs for all stakeholders	As *"an approach to support and implement processes of open innovation in the context of academy-society collaboration projects, and, as a part of this endeavor, suggest roads to new environments for academic research and education." (p. 3)* *As "an environment that attracts organisations, researchers, students, cases, fundings, and innovations, and is efficient in delievering new knowledge and innovations relevant to the actors involved." (p. 5)*	Levén & Holmström 2008
Living lab	- Real-life environment - Authentic context - Utilise pedagogical method - Engage students for real-life problem development	As "*open innovation platforms, which offer research, development and innovation services in real-life environments.*" (p. 589*)*	Luojus & Vilkki 2008
Living lab	Living lab consists of six elements - User involvement - Service creation - Infrastructure - Governance - Methods and tools - Innovation outcomes (Tangible and intangible innovations)	*As "a research methodology for sensing, prototyping, validating, and refining complex solutions in multiple and evolving real-life contexts." (p. 2)*	Mulder et al. 2008
Living lab	- Real-life environment - Experimental field - Archetypes of users - User methods	As *"an 'experimental field' within a socio-technological scope with specific goals and a specific structure, but simultaneously dealing with the uncontrollable dynamics of everyday life." (p. 99)*	Pierson et al. 2008
Living lab	- Five key principles; continuity, openness, realism, empowerment of users and spontaneity - 10 guidelines	As "*a human-centric research and development approach in which IT-systems are co-created, tested, and evaluated in the users' own private context, in abstract." (p. X)*	Ståhlbröst 2008
Living lab	- Iterative FormIT process - Main phases discovery, design and evaluation	*"As a human- centric environment supportive of open innovation process." (p. 64)*	Ståhlbröst & Bergvall-Kåreborn 2008
Living lab	- Multimethods	*"As a multiple mixed-methods approach, taking into account the heterogeneous nature and complexity of*	Schaffers et al. 2009

	- Long term - Phased cyclic approach - Joint infrastructure	*the different communities, settings and stakeholders involved." (p. 7)*	
Living lab	- Collaborative multi-contextual empirical real-world environment - Multiple stakeholders - Important role of a citizen, user, consumer or worker	*As a "environment [is] a successful way of supporting enterprises to focus on their distinctive competencies, and instead become a node in value chain networks consisting of other enterprises, stakeholders from the social sector (in many of our cases e.g. the municipality and care giving organizations), academia and user organizations and/or end users/consumers.," (p. 8)*	Svensson & Ihlström Eriksson 2009
Living lab	- Network - Three principles: openness, realism and empowerment of users	*As "an open innovation environment in real-life settings in which user-driven innovation is the co-creation process for new services, products and societal infrastructures. Living Labs encompass societal and technological dimensions simultaneously in a business-citizens-government-academia partnership'." (p. 357)*	Bergvall-Kåreborn & Ståhlbröst 2009
Living lab	- Shared arena for innovation co-creating, testing and evaluation - Human-centric research and development - Real-world setting - Five key principles: continuity, openness, realism, empowerment of users and spontaneity	As "*environment in which people and technology are gathered and in which the everyday context and user needs stimulate and challenge both research and development since authorities and citizens take active part in the innovation process." (p. 1)*	Bergvall-Kåreborn et al. 2009a
Living lab	- Milieu (environment, arena) - Approach (methodology, innovation approach) - Five key principles: continuity, openness, realism, empowerment of users and spontaneity	As *"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." (p. 3)*	Bergvall-Kåreborn et al. 2009b
Living lab	- Open innovation - Multiorganisational innovation - Focal point for collaboration - Operational, functional and strategic level	As a tool for open innovation and a focal point for multiorganizational and multilevel collaboration	Kviselius et al. 2009
Living lab	- Innovation environment - Real-life setting - User-driven - Living lab network	As "*not a network of infrastructure and services"* but also *"a living network of real people with rich experiences." (p. 1)*	Mulder & Stappers 2009
Living lab	- Real-life environments - Studying user by methods	As *"studying the users in real-life environments through a combination of quantitative and qualitative*	Schuurman & De Marez 2009

	- Collaboration between partners	*research methods (interactionist approach), the possibility of an iterative (pre-launch) research process and the establishment through collaboration between multiple research partners (mostly public as well as private)" (p. 6)*	
Living lab	- Systems - Incorporate various types of thinking: collaborative, innovation, discovery, process and strategic thinking - Factories	As *"a real-time experimental environment that enables different role players with some or other common interest within a domain to collaborate in the use and development of innovative ideas to solve current and real world problems in a unique and integrated way." (p. 430)*	van der Walt et al. 2009
Living lab	- Network of living labs as an innovation system - Multistakeholder - Contact, communication and collaboration	As a social configuration, which is organised in innovation creation by contact, communication and collaboration	Dutilleul et al. 2010
Living lab	- Cross border - Public-private partnership - Real-life environment	As *"a human-centric research and development approach in which new technologies are co-created, tested, and evaluated in the users' own private context." (p. 1089)* *As" a system for building future economy in which real-life user-centric research and innovation will be a normal co-creation technique for new products, services and societal infrastructure." (p. 1091)*	Lepik et al. 2010
Living lab	- Concept - Real-life environment - Multiple stakeholders - A variety of multiple users	*"…as a systemic, methodological instrument incorporating a number of crucial insights linked to advances in the innovation management and user research-literature, especially the increased importance of the user." (p. 1)*	Schuurman et al. 2010b
Living lab	- Open innovation intermediary - Exploration and exploitation - Innovation types and outcomes	*"As open innovation intermediaries that seek to mediate between users, research, public and private organisations, advance our concept of technology transfer by incorporating not only the user based experimentation, but also by engaging firms and public organisations in a process of learning and the creation of pre-commercial demand." (p. 100)*	Almirall & Wareham 2011
Living lab	- Cross-border living lab network - Managed collaborative network - Internal transparency - Direct communication	*"As managed collaboration networks (as opposite to self organizing networks), which feature internal transparency and direct communication." (p. 3)*	Lievens et al. 2011

	- Ecosystem with stakeholder and users		
Living lab	- Multistakeholder approach: user provider, enabler and utilizer - A form of open innovation - Co-creation with users	As *"experimentation environments; they are physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies, services, products and systems in real-life contexts." (p. 20)*	Westerlund & Leminen 2011
Living lab	- Methodology - Collaboration - Innovation in social space	As "*methodology for collaborative placed-based innovation.*" (p. 672)	Edwards-Schachter et al. 2012
Living lab	- Methods for customer involvement - Type of users - Contexts - Output - 'In situ' data capturing in a customer's use situation and 'Ex situ' capturing outside the use situation	*As a ' family of methods' that contains many different tools usually involves constructing a virtual spatial context, either with physical material or with computer software. Living Labs users act alone, in interaction with other users or other stakeholders. Instead of 'tools for user innovation', Living Labs can be seen as a 'context for user innovation'. Within the context, situations are simulated to create conditions to generate customer-driven information." (p. 424)*	Edvardsson et al. 2012
Living lab	- Multi-mode - Multi-stakeholder - Multi-discipline - Multi-method - Multi-culturally	As "*a human-technology interaction innovation entity utilizing a mix of methods, tools and principles drawn from known disciplines (design, science, ict, etc.) and set in a real environment and in a locale/societal scale. In addition, Living Lab operates in a "multi-" mode that is evident by its multi-stakeholder, and multi-discipline, nature which eventually leads to a multi-method approach, and often implemented multi-culturally for an internationally collaborated Living Lab project. The phenomenon is within the context of innovation and has multiple applications."* (p. 6)	Fulgencio et al. 2012
Living lab	- Utilizer-driven - Enabler-driven - Provider-driven - User-driven	As in accordance with a definition of living labs by Westerlund and Leminen (2011)	Leminen et al. 2012a
Living lab	- Technical and socio-economic systems - Social need of people - Sustainable development	*"As a combined lab-/household system, analysing existing product-service systems (PSS) as well as technical and socio-economic influences focused on the social needs of people, aiming at the development of integrated technical and social innovations – new product mixes, services and societal infrastructures –*	Liedtke et al. 2012

		and simultaneously promoting the conditions of sustainable development (highest resource efficiency, highest user orientation, etc.) and respect the limited numbers of natural services that can be used without destroying the ecological system." (p. 109)	
Living lab	- Iterative design process - User experience - Stakeholders - Co-create and explore value proposition	*As "an iterative experiential design process is to support the design for user experience." (p. 3)*	Pallot & Pawar 2012
Living lab	- Living lab environment - Methodology - Ecosystem with stakeholders	In accordance with definitions of Ballon et al. (2005) and Schaffers et al. (2007) *"as a user-centric and multi-party collaborative R&D methodology or environment where innovations such as new services are created and validated in multi-contextual real-life environment within individual regions." (p. 107)*	Tang et al. 2012
Living lab	- Innovation infrastructure - Participative strategies - Maximisation of socioeconomic conditions	As *"innovation infrastructures within which software companies and research organizations collaborate with lead users and early adopters in creating participative strategies to define, design, develop, and validate new products and services that maximize the socioeconomic conditions of the partnership." (p. 29)*	Guzmán et al. 2013
Living lab	- Platform - Methodology - Setting	*"As a platform, methodology and setting." (p. 16)*	Sauer 2013
Living lab	- Living lab environment - Living lab approach - Living lab outcome	As in accordance with a definition of living labs by Westerlund and Leminen (2011)	Veeckman et al. 2013
Living lab	- Activity - Phase - Collaboration - Method	As longitudinal research collaboration, this involves same users and stakeholders for a whole span of development project.	Ogonowski et al. 2013
Living lab	- R&D methodology - Top-down - Bottom-up - Smart city	*"as a research and development methodology that allows the creation of products and services at the overlap between top-down and bottom-up Smart city perspectives." (p.118)*	Coenen et al. 2014
Living lab	- Methodology - Context - Co-creation	*As " a design research methodology aimed at co-creating innovation through the involvement of aware users in a real-life settings." (p. 139)*	Dell'Era & Landoni 2014
Living lab	- Methodologies - Communities - Complex problems	*"Living labs generate not only new methodologies but also help to organize complex communities (e.g., including universities, local authorities,*	Gray et al. 2014

		companies, and citizens) in co-designing solutions for complex problems." (p. 51)	
Living lab	- Real-life environment - Stakeholders - Strategy - Innovation outcome including both incremental and radical innovation as well tangible and intangible innovations	*In accordance with Leminen and Westerlund (2012) living labs are "physical regions or virtual realities, or interaction spaces, in which stakeholders form public-private-people partnerships (4Ps) of companies, public agencies, universities, users, and other stakeholders, all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts." (p. 282)*	Leminen & Westerlund 2014
Living lab	- Open innovation paradigm - Users - Real-life contexts	*"Living Lab is the development of open innovation paradigm which combines the advantages of users and their real-life contexts and provides a structure and governance for involving users." (p. 15)*	Tang & Hämäläinen 2014
Living labbing	- Involvement of citizens and business - Multistakeholder - Public-private-people partnership - Platform	*As "involvement of citizens and businesses helps to strengthen a culture of innovation and to raise the awareness of policy makers towards the socioeconomic value of infrastructure investments." (p. 133).*	Molinari 2011
Living labbing	- Living methodologies - Citizens participations	*"Enable citizens to co-develop their city." (p. 39)*	Mulder 2012

Appendix 3. Living lab activities and their use contexts in definitions of living labs

Activities	Example of "use contexts"

• Aiming [44,59] ,targeting [32], pursuing [11] ,suggesting [34]
• Organizing [49,68], facilitating [44], governing [29] ,directing [53], driving [28]
• Contacting [49]
• Capturing [5], gathering [9,10,43], collecting [11], raising [72]
• Interpreting [6], analysing [7,59],
• Understanding [6], studying [8,28,33,47], examing [27], defining [62], discovering [32]
• Exposing [32], interacting [56], communicating [49]
• Offering [35], supporting [24,34,38,39,41,60], promoting [59]
• Solving [48]
• Featuring [53]
• Utilizing [57], using [48]
• Stimulating [43], maximizing [62], strengthening [72], challenging [43]
• Attracting [34], involving [66,67], engaging [44,52]
• Integrating [15,16,33], combining [70], encompassing [42], incorporating [51], taking part [25,43]
• Providing [14,29,17,70], enabling [25,48,71], allowing [40,66]
• Generating [68], constructing [56], structuring [29], establishing [47]
• Innovating [31,32],collaborating [47,49,54,58,64,62,69]
  ○ Developing [4,15,16,21,31,32,33,43,48,62,70], co-developing [71]
  ○ Designing [21,62], co-designing [68]
  ○ Creating [16,18,20,22,23,44,50,52,54,58,61,62,64,66,69]
  ○ Co-creating [11,30,38,39,50,67]
  ○ Experimenting [19]
• Implementing [4,34,57]
• Testing [12,14,21,22,38,50,54,58,64,69]
  ○ Validating [20,22,23,36,54,58,61,62,64,69]
  ○ Evaluating [8,21,32,38,50]
  ○ Sensing [36]
• Prototyping [22,36,54,58,64,69], demonstrating [8]
• Refining [36]
• Delivering [34], mediating [52]
• Learning [3,5,52], exercising [5]
• Teaching [5]
	• 'Activities conducted in'
	  ○ Environment [1,11,31,32,34,41,61]
	  ○ Real-life contexts or settings [1942,44,47,48] real-life or use environment [20,23,24,30]
	  ○ Experimentation environment [54,58,64]
	  ○ Collaborative virtual networks [22]
	  ○ Virtual reality(ies) [69]
	  ○ Living room [2]
	  ○ Class room [5]
	  ○ Home [6,8]
	  ○ Building [17]
	  ○ Facilities [21]
	  ○ Physical regions [69]
	  ○ City neighbourhood [3]
	  ○ City or smart city [22,66,71]
	  ○ City regions[22], rural areas[22]
	  ○ Country [12]
	• 'Activities conducted with'
	  ○ People [25,27,59]
	  ○ Users [2,9,10,19,20,21,25,28,33,41,43,44,47,50,51,52,56,60,62,63,64,70]
	  ○ Consumers [41]
	  ○ Citizens [22,43,68,71,72]
	  ○ Students [2,34]
	  ○ Employees [14]
	  ○ Developers [28]
	  ○ Academia, universities or research centres [41,52,62,68], researchers [34]
	  ○ Stakeholders [11,29,30,40,41,57,64], partners [44,47], players [48]
	  ○ Intermediary [29]
	  ○ Public or local and central authorities, municipalities [22,24,41,43,52,68]
	  ○ Firms or enterprises [22,41,52,62,68,72]
	  ○ "4Ps" [42,54,58,64,59]
	• 'Activities targeted to'
	  ○ User responses [2], user behaviour [9,10]
	  ○ Experiences (by ubiquitous computing) [5]
	  ○ Experiences or user experience [5,60]

	○ Knowledge [34], data [9,10], information [14] ○ Ideas [48] ○ Innovation [24,26,28,34,49,56,67], innovation results [11], technological or societal innovations [59] ○ Prototype [14], applications [23], ○ Services [22,23,30,35,42,54,58,59,62,64,66,69] ○ Products [23,30,42,50,54,58,59,62,64,6669] ○ Solutions for complex problems [68] ○ ICT solutions [32], complex solutions [36] ○ Systems [54,58,64,69], IT systems [38] ○ Societal infrastructures [42,50,59] ○ Technologies [22,27,30,50,54,58,64,69] ○ Business [22,30] ○ Markets [22] ○ Building technology [8] ○ Development and innovation services [35]

[1] (Knight, 1749) [2] (The Billboard weekly magazine 1956) [3] (Bajgier et al., 1991) [4] (Bengtson 1994) [5] (Abowd, 1999) [6] (Kidd et al., 1999) [7] (Benne & Fisk, 2000) [8] (Intille, 2002) [9] (Intille et al., 2005) [10] (Intille et al., 2006) [11] (Kusiak ,2007) [12] (Moffat, 1990) [13] (Tarricone, 1990) [14] (Lasher et al., 1991) [15] (McNeese et al., 1999) [16] (McNeese et al., 2000) [17] (Markopoulos & Rauterberg, 2000) [18] (Hoving, 2003) [19] (Ballon et al., 2005) [20] (Eriksson, Niitamo & Kulkki, 2005) [21] (Pierson & Lievens, 2005) [22] (Niitamo et al., 2006) [23] (Ponce de Leon et al., 2006) [24] (Ståhlbröst, 2006) [25] (CoreLabs, 2007) [26] (Fahy et al., 2007) [27] (Lacasa et al., 2007) [28] (Schaffers & Kulkki, 2007) [29] (Almirall & Wareham, 2008a) [30] (Feurstein et al., 2008) [31] (Følstad, 2008a) [32] (Følstad, 2008b) [33] (Konsti-Laakso et al., 2008) [34] (Levén & Holmström, 2008) [35] (Luojus & Vilkki, 2008) [36] (Mulder et al., 2008) [37] (Pierson et al., 2008) [38] (Ståhlbröst, 2008) [39] (Ståhlbröst & Bergvall-Kåreborn, 2008) [40] (Schaffers et al., 2009) [41] (Svensson & Ihlström Eriksson, 2009) [42] (Bergvall-Kåreborn & Ståhlbröst, 2009) [43] (Bergvall-Kåreborn et al., 2009a) [44] (Bergvall-Kåreborn et al., 2009b) [45] (Kviselius et al., 2009) [46] (Mulder & Stappers, 2009) [47] (Schuurman & De Marez, 2009) [48] (van der Walt et al., 2009) [49] (Dutilleul et al., 2010) [50] (Lepik et al., 2010) [51] (Schuurman et al., 2010b) [52] (Almirall & Wareham, 2011) [53] (Lievens et al., 2011) [54] (Westerlund & Leminen, 2011) [55] (Edwards-Schachter et al., 2012) [56] (Edvardsson et al., 2012) [57] (Fulgencio et al., 2012) [58] (Leminen et al., 2012a) [59] (Liedtke et al., 2012) [60] (Pallot & Pawar, 2012) [61] (Tang et al., 2012) [61] (Fulgencio et al., 2012) [62] (Guzmán et al., 2013) [63] (Sauer, 2013) [64] (Veeckman et al., 2013) [65] (Ogonowski et al., 2013) [66] (Coenen et al., 2014) [67] (Dell'Era & Landoni, 2014) [68] (Gray et al., 2014) [69] (Leminen & Westerlund, 2014) [70] (Tang & Hämäläinen, 2014) [71] (Molinari, 2011) [72] (Mulder, 2012)

Appendix 4. Themes of interviews

1. Introductory questions and background mapping

- Describe your tasks and areas of responsibility in the living lab.
- How do you perceive the living lab approach? What does it mean to you personally?
- Please describe what a living lab is and what it looks like.
- Describe the living lab: tasks, goals and activities.
- Please explain used methodologies.

2. Questions concerning how the living lab is organised

- How is the living lab activity organised? Describe the process: who, what, when, how.
- How living labs are interlinked to phases of innovation?
- Describe in which ways your organisation is involved in the living lab activities.
- Which actors do you co-operate with in the living lab? Please draw a picture of the actors and the living lab network.
- Which actors are participating in the living lab? Describe the roles of the main actors in the network.
- Describe your role in the living lab. What are your tasks?
- How were the decisions on roles reached?
- Are there any specific actors that should be involved in the network?
- How are the users/user communities involved in the living lab activity?
- Which users are the most active?
- Which groups of users are involved in the living lab activity? What is their specific role in the network?

3. Questions concerning how the living lab is actualised

- What are the business and operational goals of your organisation?
- How living labs are interlinkages to such goals?
- What are aims or goals of living lab activities?
- Who is responsible for living lab activities, and how are goals of living labs followed?
- How do living labs support the main activities of your organisation?
- What are the main development areas of living labs and what are your suggestions for such areas?
- How do the different actors (including users) participate in the development of action? Which user/user communities and actors are the most active in this development?
- Please describe benefits to users actively participating in the development process. Are there any disadvantages in the process?

- Please name the three most significant events in the development of the living lab.
- Please describe the living lab activity, i.e. what happens during the development (a chronological description of the progress)?
- In which phases, activities or actions do you see your role and resources important?
- How are living labs operationalised and seen in your businesses?
- Which tools do you use in living labs?
- How are knowledge and skills developed in the living lab?

4. Questions concerning the results of the living lab

- What results has the living lab reached? Please give examples and descriptions.
- What are the results from the living lab activity for your business or organisation?
- Are there any other actors or parties who benefit from the results of the living lab?

5. Conclusive questions

- What are your future visions of living labs?
- How would you develop living labs to offer further benefits for your organisations?
- Are there any other key actors you can think of where open innovation or living labs are concerned?
- Would you like to point out something important on open innovation/living labs?
- In your opinion, whom should we interview to learn more about the living lab?
- Do you have other comments or anything else you would like to add?

Appendix 5. Overview of living labs

Living labs case	Objectives	Interviewed persons	Innovation outcome	Date of Interview
Case 1 (Finland)	To find new digital service ideas without sharing its own development activities in a closed and monitored living lab environment	Project manager	Incremental improvements of digital services	23 April 2009
Case 2 (Finland)	To develop and test welfare products and services by identifying problems and development areas in a closed and monitored living lab environment	Project manager	Incremental improvements for welfare products and services	30 November 2009
Case 3 (Finland)	To develop concepts for electronic service payments within the health care sector, for municipalities and the private sector.	CEO	Incremental innovations in electronic service payments	1 February 2010
Case 4 (Finland)	To test and develop media services and new service concepts in cooperation with end users in their own home environment.	Business development manager	Incremental innovation for media services	28 October 2008
Case 5 (Finland)	To improve clients' product and service innovation processes involving the clients' end customers. The living lab is closed and monitored.	CEO	Incremental improvement for product and service innovation processes	4 March 2010
Case 6 (Finland)	To develop and test mobile ticketing services of public transportation in cooperation with end users.	Business area director, consultant, usability expert	Incremental innovation for mobile ticketing services	3 March 2009

Case 7 (Finland)	To develop augmented reality services for a new mobile gadget in cooperation with end users.	Research director Director Project manager #1-2, Senior market analyst Chief evangelist	Radical innovation of augmented reality services for a new mobile gadget	15 March 2009 5 May 2009 26 November 2009 12 February 2010 3 December 2009 13 February 2009
Case 8 (Finland)	To develop an electric car and related concepts in cooperation with user communities.	Project developer (member of the user community)	Incremental innovation for electric car concepts	21 November 2011
Case 9 (Sweden)	To develop and empower user groups and marginalised groups (e.g., immigrants) to help them improve their everyday activities in an urban area.	Living labs manager	Incremental innovation for social welfare and related activities	20 April 2009
Case 10 (South Africa)	To develop services in socially deprived areas in developing countries in order to empower people to improve their everyday activities in partnership with the local communities.	Social entrepreneur, project manager, director, user developer #1-3, user #1-5	Incremental innovation of services for locals	04-14 February 2010
Case 11 (Finland)	To develop interaction among physical, virtual and social spaces in a city environment.	Professor, head of product category	Incremental innovation of interaction processes	9 December 2009
Case 12 (Finland)	To develop and test ICT-based products and services as a part of students' learning (usability studies). The closed and monitored living lab features an educational institute.	Principal lecturer #1-2	Incremental innovation for ICT-based products and services	14 March 2008 20 May 2009

		Student #1		5 February 2010
Case 13 (Finland)	To produce restaurant services as a part of bachelor's degree students' learning and studies and to develop new services, products and concepts for related firms.	Director Research director Principal Director for education Development manager #1-2 Principal lecturer #1-2 Restaurant manager Kitchen manager Trainee supervisor #1-3	Incremental innovation for learning as well as services, products and concepts	30 October 2009 30 October 2009 25 February 2010 12 November 2009 15 October 2009 23 October 2009 19 October 2009 23 October 2009 6 November 2009 6 November 2009 25 November 2009
Case 14 (Spain)	To develop methods, platforms and technologies for organisations in the process of establishing or having established living labs.	Project manager, research scientist #1-2	Incremental innovation of user-centric research	11 May 2010
Case 15 (Finland)	To develop a living lab environment and platform in which the user community develops and tests digital services that they have developed, as well as to study the user community and its digital service development processes.	Professor	Incremental innovation of the living lab environment, improvements of digital services	31 March 2010

Case 16 (Finland)	To develop and test future services as a pilot within the retail business, and to develop prototypes and concepts within the electronic and mobile business in cooperation with end users.	CEO # 1-2 Business area director Development manager Principal lecturer #1-3 Lecturer Consultant User expert #1-6	Incremental innovation of prototypes and concepts in retail business	31 January 2008 7 February 2008 20 May 2008 5 February 2008 28 January 2008 28 February 2008 14 March 2008 4 February 2008 8 February 2008 February 2008
Case 17 (Finland)	To develop and test mobile technologies and services in a real-life authentic and independent wireless development and testing environment.	CEO, CTO, director, marketing manager, project manager	Incremental innovation of mobile technologies and services	9-10 December 2009
Case 18 (Finland)	To develop concepts and product ideas during a limited time period and in a specific place, such as on a train trip from Helsinki to Shanghai.	PhD student, student	Incremental innovation of concepts and products ideas	May 2010
Case 19 (Finland)	To develop future learning environments in which special focus is put on lighting, audiovisual elements, and technology as well as the space used for creating	Principal	Incremental innovation of learning concepts in elementary school	11 December 2009

	a learning environment. The living lab develops services and products within this area.			
Case 20 (Finland)	To develop the concept of wellness-TV and related services for elderly people, in cooperation with end users.	Director Principal lecturer Project worker Student	Radical innovation of wellness-TV	28 October 2009 11 November 2009 15 October 2009 15 October 2009
Case 21 (Spain)	To develop the daily well-being of people in a chosen community, new communication and information technologies for a medical centre, proof of technology for the provider as well as social space for research and innovation at a city environment.	Project manager, research scientist, research scientist	Incremental innovation of well-being	11 May 2010
Case 22 (South Africa)	To enhance innovation and competence development of businesses and individuals by providing an open collaboration platform that offers a network for effective public and private support services in developing countries.	Research director (Professor), program manager, project manager, principal researcher, PhD student,	Incremental innovation of processes designed to enhance individual competence	04-14 February 2010
Case 23 (Finland)	To enable testing of health care products and services by employees and customers at a health centre.	Project manager, researcher, project coordinator, product test specialist	Incremental innovation of health care products and services	11 December 2009
Case 24 (Spain)	To develop and ensure basic services for citizens and organisations representing rural areas (e.g. members of agriculture cooperatives, farmers' groups,	Director, project manager	Incremental innovation of citizen services	12 May 2010

	workers); to manufacture products for agriculture in a rural area.			
Case 25 (Spain)	To develop a location-based GPS system to monitor cattle for famers in a rural area.	Director, project manager	Incremental innovation of a location based GPS system for agriculture	13 May 2010
Case 26 (Finland)	To develop a metropolitan district; improve the everyday activities of its people by empowering user group(s) in the area.	CEO #1-4 Business area director Research director Project manager #1-2 Researcher	Incremental innovation of area development	26 November 2009 15 December 2009 16 December 2009 20 January 2010 20 May 2009 16 December 2009 14 February 2009 16 February 2010 16 February 2010

Modified from Nyström et al. (2014, 490-491)

The importance and benefits of open innovation networks are widely accepted. One form of open innovation network, the living lab, is an emerging area of a research. Living labs are interesting because they represent a new way of organizing innovation activities by facing parallel socio-economic challenges and technological opportunities. This study aims to understand networks, user and stakeholder roles, and outcomes generated in living labs. The dissertation offers many theoretical contributions and defined concepts for the living labs literature but also tools and frameworks for managers and researchers to understand, identify and categorise open innovation networks and pursue innovation development in open innovation networks, particularly in living lab networks. For the future, this dissertation suggests propositions and a range of other research opportunities for open innovation networks and particularly living labs but also for contingency theory and the resource-based view.

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