

## University of Groningen

### Special Issue: Living Labs

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*Published in:*  
Technology Innovation Management Review

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*  
Publisher's PDF, also known as Version of record

*Publication date:*  
2018

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*

McPhee, C., Leminen, S., Schuurman, D., Westerlund, M., & Huizingh, K. (Eds.) (2018). Special Issue: Living Labs. *Technology Innovation Management Review*, 8(12). <https://timreview.ca/issue/2018/december>

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## **Living Labs**

Welcome to the December issue of the *Technology Innovation Management Review*. We welcome your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

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**Publisher**

The *Technology Innovation Management Review* is a monthly publication of the Talent First Network.

**ISSN**

1927-0321

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The *Technology Innovation Management Review* (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints – from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others – to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

We welcome input from readers into upcoming themes. Please visit [timreview.ca](http://timreview.ca) to suggest themes and nominate authors and guest editors.

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**About TIM**

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; [timprogram.ca](http://timprogram.ca)), an international graduate program at Carleton University in Ottawa, Canada.



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# Editorial: Living Labs

Chris McPhee, Editor-in-Chief

Seppo Leminen, Dimitri Schuurman,

Mika Westerlund, and Eelko Huizingh, Guest Editors

## From the Editor-in-Chief

Welcome to the December 2018 issue of the *Technology Innovation Management Review*. This month's editorial theme is **Living Labs**, and it is my pleasure to introduce our guest editors, who have been regular contributors to the journal on this topic: **Seppo Leminen** (Pellervo Economic Research and Aalto University, Finland, as well as Carleton University, Canada), **Dimitri Schuurman** (imec, Belgium), **Mika Westerlund** (Carleton University, Canada), and **Eelko Huizingh** (University of Groningen, The Netherlands).

Most of the articles in this issue were selected and developed from papers presented at the ISPIM Innovation Conference in Stockholm, Sweden, from June 17–20, 2018. ISPIM ([ispim-innovation.com](http://ispim-innovation.com)) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

In our January issue, we start the new year by focusing on the theme of **Technology Commercialization and Entrepreneurship** with guest editors **Ferran Giones** from the University of Southern Denmark and **Dev K. Dutta** from the University of New Hampshire in the United States.

For future issues, we welcome your submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and growing technology companies and solving practical problems in emerging domains. Please contact us ([timreview.ca/contact](mailto:timreview.ca/contact)) with potential article topics and submissions.

**Chris McPhee**  
Editor-in-Chief

## From the Guest Editors

Beginning in 2012 with the International Society for Professional Innovation Management (ISPIM) Conference in Barcelona, a Special Interest Group (SIG; [ispim-innovation.com/groups-projects](http://ispim-innovation.com/groups-projects)) on living labs has held a yearly invited speaker session, a dedicated paper track, and other activities such as thematic workshops. In 2018, the ISPIM conference took place in Stockholm, one of the central cities of the Nordic countries, which are regarded as the cradle of the living labs movement. Therefore, in this setting, it was natural for ISPIM's Living Lab SIG to team up with the *Technology Innovation Management Review* for a special issue on the theme of Living Labs with selected papers from the ISPIM 2018 conference.

Living labs are physical regions or virtual realities where stakeholders from public–private–people partnerships (4Ps) of firms, public agencies, universities, institutes, and users meet. All are collaborating to create, prototype, validate, and test new technologies, services, products, and systems in real-life contexts (Westerlund & Leminen, 2011). Since the birth of the European Network of Living Labs (ENoLL; [enoll.org](http://enoll.org)) in 2006 and the first academic publications on the subject, a lot has changed. The ENoLL has accredited over 400 living labs and now maintains an active community of about 150 members that span different areas and themes, such as smart cities, eHealth, public sector innovation, and rural development. In terms of the levels of analysis (cf. Schuurman, 2015), some living lab organizations focus on quadruple-helix consortia that tackle so-called “wicked” societal problems with involvement of all relevant stakeholders. Other living labs focus more on the meso-level, developing a specific methodology that is offered as a service to specific utilizers (Leminen, Westerlund, & Nyström, 2012). Moreover, in parallel, a lot of other “labs” have emerged, such as Fab Labs, policy labs, and other kinds of innovation labs (cf. Schuurman & Tönurist, 2017). Also, there are signs of transformations in living labs and increasing diversity of innovation labs and innovation spaces with a trend towards what can be considered third-generation living labs (Leminen, Rajahonka, & Westerlund, 2017).

## Editorial: Living Labs

*Chris McPhee, Seppo Leminen, Dimitri Schuurman, Mika Westerlund, and Eelko Huizingh*

In this special issue, the authors reflect on various aspects of living labs, positioning them next to other innovation approaches, looking into specific types of living labs, and analyzing specific methods and techniques used in living lab projects.

In the first article, **Dimitri Schuurman** from imec.livinglabs in Belgium and **Sonja Protic** from the University of Natural Resources and Life Sciences, Vienna, compare the living lab methodology with the lean startup methodology. They report on the results of an empirical investigation of 86 innovation projects. Their findings suggest that the living lab and lean startup approaches are complementary, and they argue that combining the different strengths of the two approaches can bring clear benefits.

Next, **Fernando Vilariño**, President of the European Network of Living Labs and Co-Founder of the Library Living Lab in Barcelona along with Co-Founder **Dimosthenis Karatzas**, and key contributor and user representative **Alberto Valcarce** describe how the Library Living Lab fosters innovation in cultural spaces via real-life co-creation. The specific challenges of developing an open, flexible, and inter-connected space are identified, and the interaction dynamics based on a challenge–action–return methodology definition are described through practical examples.

Then, **Marius Imset**, **Per Haavardtun**, and **Marius Stian Tannum** from the University of South-Eastern Norway focus on the multi-stakeholder element of living labs and explore the use of stakeholder analysis when setting up a living lab organization for an autonomous ferry connection. Using an action research approach with multiple iterations, they share their experiences with the process and results, and they reflect openly on the strengths and weaknesses of both the stakeholder methodology generally as well as their own implementation specifically.

In the fourth article, **Lynn Coorevits**, **Annabel Georges**, and **Dimitri Schuurman** from imec.livinglabs in Belgium examine the real-life aspect of living lab projects and introduce a framework containing four different types of living lab field tests according to the degree of realism and to the development stage. The goal of this framework is to guide practitioners to set up field tests at every stage in the living lab process.

Finally, **Mika Westerlund**, **Seppo Leminen**, and **Christ Habib**, describe work undertaken at Carleton University in Ottawa, Canada, to identify the key constructs of living labs using a qualitative research approach. By reviewing and comparing the literature on living labs with literature on user innovation and co-creation, they identify the central constructs by which living labs can be examined in terms of their defining characteristics. They then use these constructs to analyze 40 membership applications received by the European Network of Living Labs in order to reveal how the constructs show up in the operation of living labs, and they provide a research-based definition of living lab platforms.

This diverse set of articles illustrate the increasing popularity of living labs in innovation practice as well as in innovation research. However, more research is still needed in terms of living lab methods, project approaches, and organizational set-up. Therefore, we encourage the exchange of experience and knowledge from different traditions and research streams in order to enrich the valuable concept of living labs as a multi-actor, co-creative, and real-life approach to tackle innovation problems.

**Seppo Leminen, Dimitri Schuurman,  
Mika Westerlund, and Eelko Huizingh**  
Guest Editors

## Editorial: Living Labs

Chris McPhee, Seppo Leminen, Dimitri Schuurman, Mika Westerlund, and Eelko Huizingh

### About the Editors

**Chris McPhee** is Editor-in-Chief of the *Technology Innovation Management Review*. Chris holds an MASc degree in Technology Innovation Management from Carleton University in Ottawa, Canada, and BScH and MSC degrees in Biology from Queen's University in Kingston, Canada. He has nearly 20 years of management, design, and content-development experience in Canada and Scotland, primarily in the science, health, and education sectors. As an advisor and editor, he helps entrepreneurs, executives, and researchers develop and express their ideas.

**Seppo Leminen** is a Research Director at Pellervo Economic Research in Finland, and he serves as an Adjunct Professor of Business Development at Aalto University in Helsinki, Finland, and as an Adjunct Research Professor at Carleton University in Ottawa, Canada. He holds a doctoral degree in Marketing from the Hanken School of Economics in Finland and a doctoral degree in Industrial Engineering and Management from the School of Science at Aalto University. His research and consulting interests include living labs, open innovation, innovation ecosystems, robotics, the Internet of Things (IoT), as well as management models in high-tech and service-intensive industries. He is serving as an associate editor in the *BRQ Business Research Quarterly*, on the editorial board of the *Journal of Small Business Management*, as a member of the Review Board for the *Technology Innovation Management Review*, and on the Scientific Panel of the International Society for Professional Innovation Management (ISPIM). Prior to his appointment at Aalto University, he worked in the ICT and pulp and paper industries.

**Dimitri Schuurman** is the Team Lead of the Business Model and User Research Team at imec.livinglabs. He holds a PhD and a Master's degree in Communication Sciences from Ghent University in Belgium. Together with his imec colleagues, Dimitri developed a specific living lab offering targeted at entrepreneurs in which he has managed over 100 innovation projects. He is also active in the International Society for Professional Innovation Management (ISPIM) and in the European Network of Living Labs (ENoLL) as a living labs specialist. His main interests and research topics are situated in the domains of open innovation, user innovation, and innovation management.

**Mika Westerlund**, DSc (Econ), is an Associate Professor at Carleton University in Ottawa, Canada. He previously held positions as a Postdoctoral Scholar in the Haas School of Business at the University of California Berkeley and in the School of Economics at Aalto University in Helsinki, Finland. Mika earned his doctoral degree in Marketing from the Helsinki School of Economics in Finland. His research interests include open and user innovation, the Internet of Things, business strategy, and management models in high-tech and service-intensive industries.

**Eelko Huizingh** is an Associate Professor of Innovation Management and Director of the innovation Centre of Expertise Vinci at the University of Groningen, the Netherlands. He is founder of Huizingh Academic Development, offering workshops academic research and academic writing to increase the publishing performance of academics. He is also the Director of Scientific Affairs for the International Society for Professional Innovation Management (ISPIM). His academic research focuses on the intersection of innovation and entrepreneurship, marketing, and information technology. He has authored over 350 articles, has edited more than 30 special issues of journals, and has published several textbooks.

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Chris McPhee, Seppo Leminen, Dimitri Schuurman, Mika Westerlund, and Eelko Huizingh

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**Citation:** McPhee, C., Leminen, S., Schuurman, D., Westerlund, M., & Huizingh, E. 2018. Editorial: Living Labs. *Technology Innovation Management Review*, 8(12): 3–6. <http://doi.org/10.22215/timreview/1200>



**Keywords:** living labs, innovation, methodology, framework, analysis, definition, constructs, ISPIM, ENoLL, lean startup, cultural space, library, stakeholder

# Living Labs versus Lean Startups: An Empirical Investigation

Dimitri Schuurman and Sonja M. Protic

**“ We must learn what customers really want, not what they say they want or what we think they should want.**

Eric Ries

In *The Lean Startup* (2011)

Although we seem to be living in an era where founding a startup has never been easier, studies point to the high mortality rates of these organizations. This “startup hype” has also induced many practitioner-based innovation management approaches that lack empirical studies and validation. Moreover, a lot of these approaches have rather similar angles, but use different wordings. Therefore, in this article, we look into two of these “hyped” concepts: the lean startup and living labs. We review the academic studies on these topics and explore a sample of 86 entrepreneurial projects based on project characteristics and outcomes. Our main finding is that the two approaches appear to be complementary. Living labs are powerful instruments to implement the principles of the lean startup, as the real-life testing and multi-disciplinary approach of living labs seem to generate more actionable outcomes. However, living labs also require the flexibility of a startup – ideally a lean one – to actually deliver this promise. Thus, rather than picking a winner in this comparison, we argue that combining the concepts’ different strengths can bring clear benefits.

## Introduction

We must reconcile the “startup hype” that acts as a rallying cry for new entrepreneurs with the cold reality of the high mortality rates for these startups, which are typically estimated between 67% (CB Insights, 2018) and 75% (Gage, 2012). If we are to achieve – and even exceed – the promised outcomes of this focus on startup activity, we must address the high mortality rates. But how? In this article, we argue that innovation projects are a promising avenue for reducing the startup mortality. The argument is based on the assumption that “getting your first innovation project right, immediately” increases the chances of survival significantly.

Innovation management research aims to unravel the entrepreneurial process by developing frameworks and methods to manage innovation projects. An important literature stream in this domain is Chesbrough’s (2006) notion of open innovation. The open innovation literature tends to focus on the benefits of opening up organizational boundaries. Parallel with the development of

open innovation as a research framework, approaches to practically implement open innovation in organizations and in innovation projects have emerged. The majority of the approaches has a clear practitioner focus, and this field is also subject to a lot of sudden “hype” and claims of “radically new approaches” that are sometimes based on single case studies or a limited number of observations. Therefore, we argue for more empirical investigations into the practical implementation of open innovation and innovation management approaches – something which is missing in the current literature.

With this article, we want to focus on two major concepts that, in terms of attention, followers, and publications have clearly outlived their initial hype: the lean startup methodology and living labs. However, despite receiving a lot of attention and devoted followers, there has been little empirical and scientific investigation into the effectiveness and the trade-offs of these two approaches. Although there are some clear similarities and links between them, they have only rarely been



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*Dimitri Schuurman and Sonja M. Protic*

mentioned together in studies or publications. Here, we address this gap by first investigating both approaches to identify their similarities and differences. Second, we report on an empirical investigation of 86 living lab projects in terms of outcomes and project characteristics. Third, we develop propositions regarding the living lab versus lean startup approaches and suggest future research to investigate these propositions. Finally, we identify what lessons can be shared across the two approaches.

## The Lean Startup Concept

The lean startup is described as a methodology for developing businesses and products that is built upon hypothesis-driven business experimentation, iterative product launches, and validated learning (Ries, 2008; Frederiksen & Brem, 2017). The aim is to shorten product development cycles and reduce market risks by avoiding large amounts of initial funding for big product launches and subsequent failures. The iterative fine-tuning of the innovation based on validated learning from early customer feedback is regarded as the crux of this approach. Thus, in the lean startup methodology, the focus is on the formulation of assumptions related to the end user, the validation of those assumptions, and often their subsequent revision (Ries, 2008; Blank, 2006).

The lean startup methodology was first proposed by Eric Ries in 2008 based on personal experiences with high-tech startups using his personal experiences adapting lean management principles to high-tech startup companies, and was later refined into his seminal book *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* (Ries, 2011). In terms of central ideas and propositions, it is regarded as a follow-up and extension of the customer development idea from Steve Blank's *The Four Steps to the Epiphany* (2006). One of Blank's main points is that organizations were focusing too much on actual delivery and creation of a solution without taking into account consumer demand. Before listening to the customer, these companies spent months or even years perfecting the product without interacting with the customer. As a result, many of these innovations failed to reach uptake by the market because the products were not in sync with actual user needs. This led to an approach where he proposed "going lean" by basing development on iterative cycles of building, measuring, and learning – a process that is based on the principles associated with the terms "failing fast", "minimum viable product", "continuous learning", and "pivoting".

At the same time, the implied importance of intuition in the lean startup process is a reason for criticism. Often, the validation of assumptions happens in a rather "quick and dirty" fashion, with rapid iterative cycles and pivots. Pivots describe strategic changes of business concepts or products: a course correction to test a new hypothesis (Ries, 2008). One study investigated pivots in the case of 49 software startups and identified as many as 10 different types of pivot and various triggering factors (Bajwa et al., 2017).

Recently, some academic studies have investigated the principles and merits of the lean startup in light of leading theories and empirical evidence from current innovation management academic research. For example, York and Danes (2014) looked deeper into the lean startup methodology and linked it with more established concepts from the innovation management literature. They saw the lean startup as a customer development methodology in the broader theoretical context of new product development. They regarded customer development as an entrepreneurial practice within the context of earlier product development models such as Cooper's new product development (Cooper 1988, 2008) and Koen's (2004) new concept model for the "fuzzy front-end". During the essential phase of hypothesis testing, intuition is seen as having a role in the entrepreneurial process, but the entrepreneur is encouraged to collect information and survey the environment in order to make educated guesses (York & Danes, 2014).

This combination of intuition and more formal processes to reduce uncertainties by iterative and early customer involvement has been advocated by Blank (2006), Maurya (2012), and Cooper and Vaskovits (2010). York and Danes (2014) summarize the customer development model in four stages: 1) customer discovery: a focus on understanding customer problems and needs, where the goal is to establish a problem-solution fit and develop a minimum viable product (MVP); 2) customer validation: the identification of a scalable and repeatable sales model, where the goal is to establish product-market fit and find a viable business model; 3) customer creation: creating and driving end-user demand; and 4) company building: the transition of the organization from learning and discovery to efficient execution. Stage 1 already includes challenging all assumptions, whereas the product should be launched as soon as possible (i.e., as an MVP) to increase the level of feedback. Subsequently, the lean startup methodology itself can be understood as a set of tools originating

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from different business development methods. The act of hypothesis testing with potential customers is referred to as “getting out of the building” by Blank (2006), but although the wording implies doing this “outside” or in “real-life”, this actually simply refers to talking to customers, users, and experts.

Although a large number of incubators and entrepreneurship programmes apply the lean startup methodology, there is still a lack of knowledge regarding its implementation in the real world (Mansoori, 2017). Based on interviews with 11 Swedish technology startups in the setting of a prescriptive accelerator programme, Mansoori (2017) describes vicarious and experimental learning as a means for entrepreneurs to acquire and apply lean startup theory in practice. An empirical approach is also provided by Edison and co-authors (2018), who analyzed different case studies to investigate the use of the lean startup methodology to facilitate software product innovation in large companies. They identified a list of key enablers for success, such as autonomy in decision-making processes or top management support, and inhibitors, often found in complex and bureaucratic business structures that slow down development processes. Finally, a study by Ladd (2016) looked into 250 innovation teams from a cleantech accelerator programme and found out that, in general, the lean startup methodology seemed effective: teams that tested hypotheses about their venture performed almost three times better in a pitch competition (a proxy for success) than teams that did not test any hypotheses. However, the number of validated hypotheses did not show a linear correlation with the success of these teams, which indicates that too much testing can also be detrimental for startup development. Ladd (2016) identified a loss of confidence and too many changes as possible explanations of these results. A recent study by Frederiksen and Brem (2017) investigated the scientific literature in search of antecedents and empirical evidence for the main principles of the lean startup methodology. Their results indicate that, overall, the methods find considerable backing and can be recognized, at least in part, under already established constructs. Heavy use of effectuation logic is evident throughout Ries’ (2011) book, with a clear and explicit emphasis on experimentation over long-term planning, but the main elements and propositions of the lean startup can be at least partly supported by academic research.

Whereas the lean theory is often associated with technology-driven sectors, the methodology is already used in other sectors such as healthcare and communication (Silva et al., 2013). Looking at the ownership structure of

lean startups, we mostly see clear management structures that are either team-driven or company-driven, but the scientific literature generally does not elaborate on different stakeholder participation in detail. Nevertheless, Kullmar and Lallerstedt (2017) elaborated on the advantages and limitations of the lean startup approach from the perspective of three different stakeholders: entrepreneurs, business developers, and investors. Although close customer collaboration was considered crucial, the findings also indicated that, when dealing with radical innovation, customer feedback might even be counterproductive for entrepreneurs, as customers tend to focus on the delightful and frustrating aspects of the current offering, whereas radical innovation taps into more latent needs (Thiel & Masters, 2014).

In summary, there is some academic literature that supports the claims of the lean startup methodology, although the evidence is not conclusive. Moreover, the majority of the publications on the lean startup methodology do not include empirical data, but rather rely on spectacular but anecdotal “cases”.

## The Living Lab Concept

The concept of the living lab evolved from the notion of long-term field experiments in the 1980s and 1990s, to lab infrastructures aimed at testing innovations in settings aimed at recreating real-life conditions in the 1990s and 2000s, towards an innovation approach based on user co-creation and real-life experimentation in the 2000s and 2010s. Living labs are regarded as complex phenomena where three analytical levels can be distinguished: the organizational level, the project level, and the individual user interactions level (Schuurman, 2015). The living labs literature is very explicative in terms of the participating stakeholders and actors involved. This is apparent at the organizational level (e.g., Leminen, 2013; Leminen et al., 2012) or at the user interactions level (e.g., Dell’Era & Landoni, 2014; Leminen et al., 2014). For this article, we focus on the project level, which is the least discussed level in the living labs literature, as a systematic literature review revealed (Schuurman, 2015).

A living lab project approach is described as a structured approach to open innovation and user innovation (Almirall & Wareham, 2008; Leminen et al., 2012; Schuurman et al., 2016a). Thus, we look at living lab projects from an innovation management perspective. Common elements of living labs are: 1) co-creation, 2) a multi-method approach, 3) multi-stakeholder participation, 4) a real-life setting, and 5) active user involvement

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(ENoLL, 2018). In terms of methodology, most papers focus on these specific elements without going into further detail about how these elements are combined or linked in a specific methodology. The most concrete are the works of Pierson and Lievens (2005) and Schuurman and colleagues (2016a), who put forward a quasi-experimental design that includes a pre-test, an intervention, and a post-test. This quasi-experimental design – with the elements real-life experimentation, active user co-creation, and a multi-method approach – generates creative tension, according to Almirall and Wareham (2011), where user-led insights are cultivated and tacit, experiential, and domain-based knowledge is surfaced, codified, and communicated.

A key defining aspect of living labs is the real-life context, which allows the dynamics of everyday life to play a vital role in innovation processes. It includes both a regional aspect, such as pushing product tests or needs assessment in cities, rural areas, and real or virtual networks, and an everyday life context in terms of actual user involvement. The lab is anything but a solitary environment. Living labs use multiple methods such as qualitative and explorative research approaches, including, for example, ethnographic methods, co-creation sessions, field tests, and idea scouting. Again, the overall goal is to ensure a continuous, content-based interaction between the lab and its customers. The co-creation aspect and the active user involvement of living labs require strong cooperation and openness towards different actors. The testing and experimentation in real-world circumstances is a defining characteristic of living labs. Nevertheless, the literature fails to acknowledge exactly why this is the case and how it should be realized. It is the “dynamics of everyday life” that are put forward as a reason for not having a systematic or structured approach within living labs. At the same time, multi-stakeholder involvement is a central issue, and a lot of research concerns actor roles in living labs (e.g., Nyström et al., 2014; Schuurman et al., 2016b). In terms of the living lab actors, this task is carried out by the living lab researchers, who engage in a dual role of action researcher as they solve immediate problems while informing (living labs) theory (Logghe & Schuurman, 2017; Ståhlbröst, 2008). Multiple roles lead to divergent interests and an increasing complexity in decision making. However, we do not see these reasons as arguments for not following a clear structure and decision-making process. Especially when looking at the ownership and the business model of living labs, we observe a lack of clarity (Protic & Schuurman, 2018).

The five elements of living labs lead to the assumption that they are able to generate tacit and experiential knowledge that is not obtained in “traditional” innovation approaches. That is why the codifying and communicating suggests that translation of these insights is crucial. In general, we see a great variety of strategies for revenue generation among living labs (Protic & Schuurman, 2018). While some are active in the early stage of innovation processes, others are more likely to serve as test beds or urban development instruments. As Ståhlbröst (2013) describes, labs also offer predefined, fee-based services to their clients (i.e., the “living lab as a service”). In general, these labs tend to have clearer management and ownership structures, as daily operation is very similar to service-driven organizations. We can refer to iMinds Living Labs (now called imec.livinglabs: [www.imec-int.com/en/livinglabs](http://www.imec-int.com/en/livinglabs)) as an example, as this organization within a larger research institute developed into a service-driven organization after the experience of being part of three funded consortium living labs (see Schuurman, 2015 for a detailed description and analysis). In this living lab as a service organization, projects are carried out for “customers” of the living lab and thus have a clear project owner, whereas in consortium-based living labs, ownership and roles in living lab projects tends to be less clear because of the diverging interests of the consortium partners (Schuurman et al., 2016b).

There are few studies that present concrete results of the outcomes of these living lab projects, and even fewer that compare living lab projects with other innovation projects. Ståhlbröst (2012) puts forward five principles that should guide the assessment of a living lab’s impact. In a follow-up study, Ståhlbröst (2013) assesses these principles in a qualitative way for five micro-enterprises. Nevertheless, the results are rather an application of the principles than an actual impact assessment. Schaffers and colleagues (2012) reported on the results of a European project in which cross-border living lab activities led to new business opportunities and increased revenue, but the sample is also limited. Schuurman and colleagues (2016a) compared 13 projects with a full living lab methodology with 14 projects without a full living lab methodology. The main findings are that the living lab projects seem to foster more actionable user contributions than non-living-lab projects, but that the non-living-lab projects seem to advance faster when going to market, aborting a go-to-market attempt, rebooting with a new innovation project etc., whereas more living lab projects remain in the “in development” stage. Ballon and colleagues (2018)

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provide the most comprehensive study into impact assessment for living labs and come to the conclusion that impact assessment is difficult and poses severe methodological barriers to be overcome. The paper itself also reports an impact assessment of a sample of living lab projects, focusing on the economic impacts. This study also suggests the added value of a living lab approach and proposes that, although it is difficult to clearly assess impact, this does not mean that no attempts should be made to do it. In this article, we want to assist in filling this gap in research into living labs, open innovation, and user innovation by looking into a larger sample of innovation projects and juxtaposing the findings with the theoretical considerations of both living labs and the lean startup methodology.

## Methodology

In the current study, we adopt a mixed design with quantitative and qualitative data. For the quantitative part, we look at all innovation projects carried out by the user research team of imec.livinglabs (previously iMinds Living Labs and iLab.o) from 2011 up to 2018, which makes for a sample of 86 projects. This means all of the projects in our sample are linked to a living lab organization, so we cannot make a comparison with projects that adopted a lean startup methodology. However, the data from this sample allows for the investigation of certain elements of the living lab methodology, which will be contrasted with the lean startup literature in the discussion.

For this sample, we coded the presence of a real-life field trial in the projects based on the project deliverables. We also coded the status of the project in terms of project outcome: “on the market” if the innovation is available for adoption by end users, “abort” if the innovation project is stopped and the team members disband, “reboot” if the innovation project is stopped but the team members continue with a new innovation project based on the insights, and “in development” to indicate that the innovation had not yet been launched. This last category can be regarded as an “in-between state”: over time, these projects will either become available on the market, be aborted, or be rebooted. The data for the initial coding of the projects was taken from a post-assessment interview at the end of each project. However, every year this database is updated based on an online search and a personal follow-up with the project owners to assess changes. The last update of the status dates from May 2018. All of these projects were innovations with a digital component. The majority (58) had a business-to-consumer (B2C) focus, whereas the remaining 28 projects

could be labelled as business-to-business (B2B). For an idea of some of the projects, see Schuurman (2015) and Schuurman and colleagues (2016a).

For the quantitative analysis, we simply compared the numbers of the projects with a real-life field trial, which can be considered as living lab projects, with those without a real-life field trial (see Table 1). Because of the relatively small sample size as compared to the outcome categories, no chi-square tests could be performed as the expected cell numbers were less than 5 for more than 20% of the cells. Therefore, here, we simply report the percentages. For the qualitative study, we selected cases from each category (abort, reboot, in development, and on the market) and looked for further evidence related to our literature review.

## Results

The main results from the quantitative analysis for the 86 projects are summarized in Table 1. Overall, roughly 1 out of every 4 projects was stopped after the project and almost 1 out of 10 was rebooted based on the project insights, whereas 1 out of 10 are still in development or implementing the lessons learned.

In this sample of 86 projects, another striking finding becomes apparent. Overall, only a minority (42%) of all projects can be regarded as “real” living lab projects, meaning they contained a proper real-life field trial. These “innovation projects” that lacked a real-life trial were, for example, projects in which testing only took place in a laboratory setting (15 projects) or where user ideation or co-creation took place without an intervention with (i.e., a prototype of) the innovation (33 projects). This can also be explained by the fact that, already in these exploratory stages, the absence of a market need was detected, which was the case for 1 out of 5 of these projects (see also Schuurman et al., 2016a). However, in general, the majority of the projects resulted in the original innovation idea – the one under investigation at the start of the project – being launched on the market at some point. Just over half of the living lab projects with a real-life trial resulted in a market launch, but even 60% of the “innovation projects” also ended up in a market launch. It can be assumed that these entrepreneurs engaged in an innovation project with the living lab organization and either took the “exploratory” learnings from this innovation project to develop a prototype and did the testing themselves or they relied on their intuition and simply launched or aborted the project. However, more investigation would be needed to confirm these assumptions.

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**Table 1.** Comparison of the outcome of projects with and without real-life trial

Status	Living Lab Projects (With Real-Life Trial)	Innovation Projects (Without Real-Life Trial)	Overall
Abort	10 (28%)	11 (22%)	21 (24%)
Reboot	5 (14%)	2 (4%)	7 (8%)
In development	2 (6%)	7 (14%)	9 (10%)
On the market	19 (53%)	30 (60%)	49 (57%)
<b>Total</b>	<b>36 (42%)</b>	<b>50 (58%)</b>	<b>86 (100%)</b>

The biggest difference between the living lab versus innovation projects is the fact that the majority of all “reboots” occurs in projects with a real-life field trial. The percentage of market launches is slightly lower, and the percentage of “aborted” projects is higher. This seems to support the fact that real-life experimenting indeed surfaces tacit needs. This would allow a decision on whether to continue (and pursue a market launch), or to abort. Moreover, the relatively high number of reboots supports this tacit user need these, as novel tacit needs surface and elicit novel innovation ideas. However, because of the small number of reboot projects, this is again an assumption that needs further validation.

Therefore, to look for further evidence, we performed a small qualitative investigation into the five projects that included a reboot after a living lab project with a field trial. The data from these projects was gathered from the project proposals, the project deliverables, meeting notes and data from a post-assessment survey. Our findings are summarized below:

1. *InCitsy*: This project investigated the potential of a smart city platform for citizens. However, based on a test in a Flemish city, there was low interest from citizens as well as from other actors that would provide content on the platform. However, one use case, in the domain of smart energy, was relatively successful. Based on this finding, the collaboration with the energy provider was intensified and this resulted in a “smart plug” offering being launched on the market.
2. *Wadify*: The objective of this project was to create an online video platform for young people, who would be rewarded for watching advertisements. For the young people, the test was very successful, as they liked the platform very much and showed interest in

using it in the future, but the interest from advertisers was too low. However, based on the discussions with the young people and research into their interests, the entrepreneurs made the connection between festivals and smart technologies. This resulted in Playpass, a new direction of the team behind Wadify that focused on smart wristbands for festivals. In this area, they have successfully launched their first product.

3. *Nazka*: This project dealt with the visualization of air quality metrics on maps. During the field trial, the user feedback indicated that the numbers were hard to interpret and that end users were not that interested in this data. This made the company shift from a business-to-consumer (B2C) model towards a business-to-business (B2B) model where they provided the basic infrastructure and opened up their datasets to allow other parties to re-use the data and make sense of it. In this new B2B model, they adopt a licensed-platform approach and no longer interact directly with the end user.
4. *Veltion*: This B2B startup advised companies on the optimization of production and other company processes. They developed an application that could be used by workers to report issues and suggest improvements. Within the living lab test, the application was tested and the experiences of two companies were positive and satisfying. However, interviews with the company managers also revealed that this usage would cannibalize their regular service offering, as it would potentially replace their consulting business. The positive field trial paired with these insights made them change their initial idea, and they now use an adapted form of the application as an “add-on” to their consulting business rather than a standalone offering.

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5. *Planza*: This planning tool was initially oriented as a consumer service. The field trial revealed a positive user experience, but indicated a lack of “willingness to pay”. Thus, the original idea behind Planza was deemed not viable, and the team shifted towards a B2B approach. The platform was stripped to keep the functionalities that were of interest in a B2B-setting, and the result was a planning tool for companies.

The above examples indicate that putting the innovation to the test in a proper real-life field trial helps the projects validate critical assumptions and take key decisions regarding the next steps in their innovation development process. One finding that can be abstracted from the cases is that the reboots were not only driven by user insights, but also could be linked to business model insights. This combination of business model research with user research is one of the key assets within imec.livinglabs, but is rarely present in other living labs (see Rits et al., 2015). This is attained by starting all projects with a business model analysis to identify the key uncertainties, which enables the lab to tailor the user involvement activities and real-life tests towards filling these gaps, and by having multi-disciplinary teams of business and user researchers carrying out the projects (see also Schuurman et al., 2018). The experiential learning of user research and real-life field trials seems to provide actionable data that can be used as “evidence” for designing and iterating the business model. Moreover, this multi-disciplinary approach is also an aspect that drives entrepreneurs to use the services of a living lab. First, not all expertise is present in the entrepreneurial team, and time and resources are limited. Therefore, external sourcing of capabilities can shorten development cycles and save effort, as some critical aspects can be outsourced. However, this requires an accurate process of hypotheses building and prioritizing to identify which one should be tackled first. More guidelines and investigation seem necessary in these matters to develop the thinking further.

### Discussion and Conclusion

Within this article, we looked into the similarities and differences between two concepts that focus on a practical implementation of open innovation. Both living labs and the lean startup methodology are mainly practitioner-driven and both have an avid base of “believers”. However, for both concepts, there is a lack of quantitative studies that measure impact and outcomes of these approaches in a more systematic manner. Moreover, despite some obvious similarities, both concepts are rarely studied or mentioned together.

Building upon lessons learned, Table 2 compares the two concepts in terms of their various stages, their focus and real-life context, the methodology mainly applied, and the ownership structure.

Based on the gained insights, we can conclude that both approaches start from customer development as the basis to successful innovation. Whereas the lean startup is more explicitly positioned as an innovation management approach with a clearly different approach compared to the traditional stage-gate new product development process, the living lab approach is very explicative in terms of the participating actors and stakeholders, active user co-creation, and real-life experience. However, in terms of innovation management approach, the living labs literature is underdeveloped.

The four stages of the lean startup offer anchor points for the living lab elements. Especially in the first two stages, a living lab approach seems compatible with the goals of problem-solution and product-market fit. Even the customer creation stage can be tackled with a living lab approach, as long-term user involvement might generate initial user demand and innovation advocates (Almirall & Wareham, 2011; Schuurman, 2015).

The lean startup literature focuses on formulating assumptions related to the end user and fast iterations of assumption validations by “getting out of the building”. While it simply aims to interact with (potential) end users and stakeholders in order to validate assumptions, the living lab approach allows the dynamics of everyday life to play a vital role in the shaping of the innovation. In a way, the use of external sources of knowledge is much more intentional and limited in the case of the lean startup.

Looking at the “methodological toolbox” that is linked to both approaches, the lean startup focuses more on quantitative methods and metrics, whereas living labs also emphasize qualitative and explorative research approaches (such as ethnography, co-creation sessions, etc.). Especially in the first stage of the lean startup process, more qualitative methods seem appropriate, whereas for product-market fit, more quantitative methods seem appropriate.

One of the other major distinctions between both concepts is the ownership of the process. In the lean startup, there is a clear entrepreneur or innovator, or in most cases an innovation team. In living labs, this ownership is less clear, except in organizations offering a

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**Table 2.** Comparison of the lean startup and living lab methodologies

	Lean Startup	Living Lab
<b>Focus</b>	Clearly positioned as an innovation management approach.	Very explicative in terms of the participating actors and stakeholders, co-creation, and real-life experience.
<b>Stages</b>	1. Customer discovery 2. Customer validation 3. Customer creation 4. Company building  (Cooper & Vaskovits, 2010; York & Danes, 2014)  Combined with “getting out of the building” for assumption testing.	1. Pre-test 2. Intervention 3. Post-test  (Pierson & Lievens, 2005; Schuurman et al., 2016a)  Combined with real-life experimentation, active user co-creation and a multi-method approach.
<b>Real-life</b>	Focus on formulating assumptions related to the end user and fast iterations of assumption validations by “getting out of the building” only.	Allow the dynamics of everyday life to play a vital role in the shaping of the innovation.
<b>User role</b>	User feedback used for assumption testing.	The user is continuously involved in the innovation process.
<b>Methodology</b>	The focus is mainly on quantitative methods and metrics.	Emphasizes qualitative and explorative research approaches.
<b>Stakeholder participation</b>	Lack of detailed elaboration on participation by different stakeholders.	Multi-stakeholder involvement as a central topic (e.g., Nyström et al., 2014; Schuurman et al., 2016b).
<b>Ownership</b>	Clear entrepreneur or innovator, or in most cases an innovation team.	Ownership often unclear, unless in the “living labs as a service” model.

“living lab as service”. This leads us to conclude that both approaches are rather complementary to one another. For living labs, the lesson learned from the lean startup methodology would be to incorporate a more structured and iterative process with clear decision making and ownership. Also, the flexibility and the rapid iterations can be valuable principles to structure living lab operations.

On the other hand, lean startups can learn from the multi-stakeholder interactions and the co-creative approach to innovation. The multi-faceted, multi-disciplinary nature of living lab organizations can be of critical value. This allows startups to involve the most needed expertise at the ideal moment, given that most critical assumptions are detected. Moreover, from the discussion above, we can assume that “getting out of the building” in real-life might provide more actionable input than plain and simple user interactions. For living

labs, this poses the challenge of being flexible in terms of project set-up and execution, whereas for startups, capturing and prioritizing assumptions is crucial. Therefore, we plead for both approaches to exchange experiences and adopt best practices from one another. For our own part, we are trying to facilitate this exchange through the Living Labs Special Interest Group of the International Society for Professional Innovation Management (ISPIM; [ispim-innovation.com](http://ispim-innovation.com)), where living lab researchers and practitioners meet with general innovation managers practicing the lean startup methodology. Indeed, the lean startup methodology seems like a great do-it-yourself (DIY) toolkit, whereas living lab organizations seem to be able to complement the entrepreneurial team capabilities where necessary and provide multi-stakeholder inputs and real-life experience. By acting this way, we foresee that it becomes possible to learn what customers really want, not what they say they want or what we think they should want.

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In terms of limitations and future research, the most important limitation of this study is the absence of data on lean startup projects. This would allow an empirical analysis to grasp differences between both approaches. At imec, all the living lab projects as well as all activities in the imec's iStart incubation programme are assessed in a similar way at the start and at the end of the project or coaching period, a dataset containing this type of data is being generated at the moment. However, data from multiple organizations is needed for a broader investigation. This will allow more detailed and statistical analyses in the future. We also urge other researchers to try and gather larger datasets in order to move the research from exploration to validation. This would definitely help startups and entrepreneurs make a more rational choice between various options and approaches.

## Acknowledgements

This article was developed from a paper presented at the ISPIM Innovation Conference in Stockholm, Sweden, June 17–20, 2018. ISPIM ([ispim-innovation.com](http://ispim-innovation.com)) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

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**Citation:** Schuurman, D., & Protic, S. M. 2018. Living Labs versus Lean Startups: An Empirical Investigation. *Technology Innovation Management Review*, 8(12): 7–16.  
<http://doi.org/10.22215/timreview/1201>



**Keywords:** living lab, lean startup, entrepreneurs, open innovation, user innovation, testing, impact, innovation management

# The Library Living Lab: A Collaborative Innovation Model for Public Libraries

Fernando Vilariño, Dimosthenis Karatzas, and Alberto Valcarce

“È questa una biblioteca possibile o appartiene solo  
a un universo di fantasia?”

Umberto Eco (1932–2016)

In *De Bibliotheca* (1981)

About an imaginary – almost infinite – library

New models of governance advance towards participatory schemes in which citizens not only play an active role in decision-making processes but also the processes by which new products and services are defined and introduced. In parallel, technological innovations, and the new horizons of creativity that they allow, open a huge range of options to innovation in all areas of society, particularly in the cultural field. Under these two premises – participation and innovation – the Library Living Lab initiative was born at the Public Library of Miquel Batllori Volpelleres in Sant Cugat del Vallès, Barcelona. The Library Living Lab is a space that gathers all stakeholders around the public library with the aim of exploring new methods and tools that allow us to enjoy culture both individually and collectively. This article describes how technology can be an enabling factor in a citizen-initiated grassroots project. The project implements a complete model of inter-institutional collaboration with all relevant actors around the living lab working group. The specific challenges of developing an open, flexible, and inter-connected space are identified, and the interaction dynamics based on a challenge–action–return methodology definition are described through practical examples. Our conclusions tackle the challenges of a horizon for the implementation of innovation initiatives – such as living labs – in public spaces.

## Introduction

The Library Living Lab is essentially a space of experiences. It is a place where we can explore how technology transforms the ways in which we enjoy culture. This exploration is made possible by adopting the perspective of innovation through which the public library provides the context of a meeting place for diverse perspectives.

Living labs are defined by the European Union as user-centric innovation environments (Eskelinen et al., 2015), in which creators, managers, and users can participate in co-creating innovations that enable social and economic impact. For this impact to produce a significant change there must be an open and trustful ecosystem of various actors, from researchers (carriers of new ideas and technologies), administrators (policy makers and driving actors for the transformation of ideas into

services), private organizations (allowing sustainable models), to ordinary people (for, with, and by whom innovation is taking place).

From this perspective, the Library Living Lab in Barcelona transforms a library space into a place in which all stakeholders, and specifically users of the public library, are invited to participate in the definition cycle of a potential service around an innovative experience. The result is a laboratory where it is possible to design prototypes of new tools and services, but it is also a social innovation laboratory where research is carried on the dynamics that lead to such innovation processes (Carayannis & Campbell, 2009). In the specific case of the Library Living Lab, these activities are sustained on two fundamental pillars:

1. The exploration of technology as an enabling factor for experiences and transformative value services.

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2. The continued questioning of the role of public space in society, transforming it into a place of innovation where we all are actors.

These ideas are developed in this article according to the following structure. First, we explain the origin of the project in the context of a more participatory society, and we describe our proposal for a new model of inter-institutional collaboration with all relevant stakeholders. Next, we describe the design and implementation of our innovation space, and the introduction of the “social challenge–action–return” strategy. Examples illustrate our approach and introduce the transformative value of the living lab in the library. Finally, we summarize the main findings and provide conclusions.

## Towards a More Participatory Society: A Project Born from a Citizen Initiative

The Library Living Lab project is a successful example of a grassroots initiative that has taken the combined efforts of all participants (DG Connect, 2015). It was born out of necessity in response to an appeal by local residents of the municipality Volpelleres Sant Cugat del Vallès, Barcelona. Due to strong demand for homes in Sant Cugat in the late 1990s, the Council agreed to the development of the northern municipality. From 2000 to 2006 the first 3,352 planned dwellings were developed. Unfortunately, the bursting of the housing bubble in 2007 and 2008 halted the consolidation of the newly born district, which was populated mainly by young couples who had seen San Cugat as the ideal place to raise their families.

The economic crisis left half a district under development, and much of the projected infrastructure had not yet been built. In this context, some neighbours who worried about their present and future decided to organize themselves and founded the Association of Residents of the Neighbourhood of Volpelleres (AVBV, in their Catalan acronym). The AVBV represented a district with a population full of vitality and deeply rooted in information technology and communications. It was a well-connected area on the edge of a major concentration of universities and research centres, as well as a variety of major companies. However, many promised services were lacking. Notably, Sant Cugat’s main plan included a proposal for the construction of a public library, although a timeline had yet to be determined. This lack of progress was seen by the AVBV as an opportunity, and its members began to work on a proposal for orienting the profile of this potential future library towards a technological focus.

This initiative – though still without form – arrived at the Computer Vision Centre (CVC), a joint partnership of the Government of Catalonia and the Universitat Autònoma de Barcelona (UAB). The CVC is a research centre leader in the area of artificial intelligence for image and video analysis, with a strong commitment to local and international projects in different fields of application. At that time, the CVC was implementing a strategic bet oriented towards the application of its core technologies in the field of culture, while investigating novel paradigms for the rapid transfer of research outcomes to the public. When the citizens representing the AVBV explained to the CVC that they wanted something innovative for the new public library, the centre proposed the creation of the first “Library Living Lab” (described below). The proposal was crafted in 2011 and it was jointly submitted by the AVBV to the mayor of Sant Cugat, who received it positively and gave it its institutional support.

The result was that the Volpelleres Library project was prioritized by the municipality. The university took on this project as part of its strategic plan, and the project definition phase began with the formation of a working group that included representatives from the municipality, the provincial government, the CVC, the university, and the AVBV. In 2014, the agreements for the implementation phase of the project were signed, and the library opened its doors in May 2015. In the summer of that same year, the Library Living Lab was accepted in the European Network of Living Labs (ENoLL; enoll.org). Then, in October of the same year, the citizens themselves presented the activities to the library users during a grand opening party. This initial implementation was run as a pilot until 2018, when it reached the two key milestones of the consolidation phase: the final model of governance was defined and the sustainability model was agreed.

## A New Model of Inter-Institutional Collaboration with all Relevant Stakeholders

The launch of the Library Living Lab involved the definition of the lab’s own dynamics around a permanent working group, in which several mechanisms of inter-institutional collaboration have been deployed. The permanent working group brought together representatives of the five participating institutions, who each have different roles, plans of action, and objectives (Table 1). The aim of the working group was the alignment of all these various objectives for the definition of the master lines of work. The group gathered for bi-monthly meetings, and its first task, and perhaps its

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**Table 1.** Participating institutions in the Library Living Lab's permanent working group

Institution	Representation	Role	Objectives
City of Sant Cugat del Vallès	Library Service Manager	Responsible for municipal allocations	Provide high-quality services in the area of culture
Provincial Council of Barcelona (DiBa)	Manager of the Network of Libraries	Service provider (DiBa, 2016)	Develop the role of the public spaces in the network of >250 libraries as meeting points and repositories of knowledge
Universitat Autònoma de Barcelona (UAB)	Head of the Office for Strategic Projects	Researchers	Extension of the university influence to the territory
Computer Vision Centre (CVC)	Associate Director and Research Staff	Catalyst and leader of the project	Research, technology transfer and training in computer vision with and by the final users (citizens)
Association of Neighbours of Volpelleres (AVBV)	Citizens; members of the association	Instigator of the initiative and final recipients of its services	A place for new services, interesting activities, and community building

most important one, was the definition of a common language to share across all institutions. This task was accomplished by “learning to talk” to other members. This learning comprised, among other things: fixing terminology and procedures, defining new fields of common knowledge, understanding what was and what was not allowed in the public space, understanding the priorities and dynamics of each institution, and establishing timeframe expectations, which were also different for each institution.

A key feature of such a group is that all the actors are directly involved in decision making, and this involvement is always based on needs and opportunities. This situation represents a new paradigm of inter-institutional collaboration. On the one hand, it allows for the definition of actions and services with high added value given that they are originally based on the real needs of the different participants. On the other hand, it requires public institutions to take on higher exposure (accountability) and public visibility of their performance and responsiveness. The main outcome of this process is the agreed prioritization of work lines, which form the basis for the subsequent concrete definition of innovation activities.

## *The benefits to each institution and the results of the collaboration*

Joint collaboration for the definition of common lines of work must allow an objectively verifiable benefit to all participants in order to ensure a sustainable project.

In the case of the Library Living Lab, the benefits to each institution can be summarized as follows:

1. The City of Sant Cugat del Vallès benefits through the creation of space for experiences by its residents. It has added value and provides a meeting place for cultural projects with all social segments of the city. This space enables the design of new models of governance focused on citizen participation.
2. The Provincial Council of Barcelona benefits through the creation of an innovation space – a place in which to securely study and define prototypes, methodologies, and protocols that may become part of new services. This endows the Library Network of Barcelona Provincial Council with a place to identify the challenges that arise on a day-by-day basis, to explore fitted solutions, to test proposals and to propose answers, all by-with-and-for the users. The scalability is guaranteed by translating the valuable solutions obtained in the Living Lab to the rest of the libraries of the Network.
3. The Universitat Autònoma de Barcelona benefits from the implementation of its living lab, which aligns with its policy of extended outreach into its surrounding territory, and it provides its scientific community with a space for citizen science.
4. The Computer Vision Centre benefits from the creation of an experimentation space for technologies

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with high added value and an implementation space for rapid technology transfer to society through fast prototyping.

5. The Association of Neighbours of Volpelleres achieves strong revitalization of its neighbourhood, access to a collection of innovative activities, and a place to enjoy culture through the latest technological tools.

Finally, the benefits of this collaboration are expected to extend beyond the membership of the working group. The citizens of Barcelona are the ultimate recipients of the benefits of the Library Living Lab, but the scheme also enables participation at the level of specific projects to other actors such as companies, which can play a key role as economic impact drivers by benefiting the entire social fabric with the emergence of new cultural products and services. In this way, the quadruple-helix model is completed.

## Design and Implementation of an Innovation Space: Open, Flexible and Interconnected

One of the most important questions about an innovation space is the design of the space itself, because a poor design jeopardizes the functionality of the project. In the case of the Library Living Lab, the specific area consists of 110m<sup>2</sup> within the Public Library of Volpelleres. However, although limited and confined to this area, the presence of the living lab transforms the whole library, inspiring its own culture of innovation that extends to every corner of the building and is shared by all of its working staff.

During the definition phase of the project, the members of the working group had the opportunity to engage directly with the team of architects in the design of the Library Living Lab in order to implement a space with three fundamental characteristics: it had to be open, flexible, and interconnected.

1. *An open space:* From a perspective of accessibility, the space is separated both physically and acoustically by a glass wall that makes it possible to visualize the activities that are taking place within it at all times. It is an open space without barriers, which invites curious people to enter, since here “openness” also means visually accessible. Access is provided through a small door at the back of the space; this entrance is designed to not disturb the ongoing activities, but it is also possible to open a large gateway through a sliding door that opens the space physically by merging it with the whole volume of the library.

2. *A flexible space:* All items of furniture, chairs, etc. are light and mobile, and they can be quickly adapted for any activity. This flexibility was a basic premise of the design and reduces the likelihood that innovation processes may be constrained by the physical limitations of the space.

3. *An interconnected space:* There is a high density of power and Ethernet connections on the floor and walls, a separate WiFi network that does not interfere with the Internet network of the wider library, and accessibility and high-capacity plugs on the ceiling, with anchoring mechanisms that allow the installation of screens, cameras, projectors, and other electronic devices.

The spirit of the design of this space is, in short, to create an infrastructure that makes it possible to live new experiences in a comfortable way, that enables rapid changes from activity to activity, and that allows the possibility of using diverse electronic devices connected to the network without limitations.

## The Dynamics of Innovation: Joint Definition of Social Challenge–Action–Return

Innovation processes share common dynamics that are tailored to specific contexts. These dynamics crystallize in the Library Living Lab in three distinct stages: identification of a social challenge, design and implementation of a specific action, and definition of a return. This approach is aligned with the main pillars described in the Responsible Research and Innovation approach (European Commission, 2016), which is used to tackle dimensions such as awareness, transparency, and openness.

1. *Social challenge:* In order to achieve social impact, it is essential for the activities of the Library Living Lab to be designed in order to advance the resolution of some of the challenges currently faced by our society. These challenges are identified within the working group, which prioritizes them according to the values and convergent interests of the various actors. This process ensures real benefits to all participants in the terms described above.
2. *Action:* Having identified a challenge, it is necessary to define a concrete action for the process of innovation, the typology of which must be specifically adapted and suited to the chosen challenge. There is no general action scheme, but the opportunity to select the most appropriate solution ensures efficient approaches to the proposed challenges.

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3. *Return*: Finally, it is essential to define a specific and objectively verifiable return, which is obtained as a result of the innovation action. This return is the commitment that the actors have towards the participants and the way in which the benefit of participation is identified for all of the Library Living Lab experiences.

Thus, the triplet of Challenge–Action–Return must be present for each activity in the laboratory and should be communicated efficiently to all actors, thereby ensuring informed and responsible decision making based on common knowledge (DiBa, 2016). Table 2 lists a number of challenges, actions, and potential returns from the early experiences with the Library Living Lab. Throughout the next section, a more detailed description of the implementation of the methodology is illustrated in three practical examples.

## Examples of Experiences born in the Library Living Lab

The methodology introduced in the preceding paragraphs results in a list of activities that implement the triplet of challenge–action–return. We must emphasize that this list of activities is always dynamic: once an activity has been completed in the laboratory (prototyping), all the comments, conclusions, and lessons learned by the various actors are collected, and the final

result can be (though is not necessarily) the viability of a new service, a new tool, etc. It is at this point that the identification of a new challenge will initiate a brand-new cycle of innovation, thus keeping active the essence of the creative process and the spirit of the innovation space. The further implementation of an actual product, policy, or service from the studied prototype relies then on the specific drivers of the socio-economic impact. The Library Living Lab contributes with its added value to the definition processes.

During the first six months of its operation, the Library Living Lab implemented a set of activities following this vision. Notable examples of these activities include the following:

1. *The Library Visits the Museum*: seeks to break down the walls that separate museums and libraries.
2. *Interest Group on Educational Apps*: investigates methods and tools for learning by using mobile applications in schools.
3. *Interest Group on 3D Printing*: collaboratively works to define the role of libraries in creation activities through 3D printers.
4. *I Am My Own Drawing*: aims to re-define the current service, which is titled “Story Time”.

**Table 2.** Examples of challenges, actions, and returns identified at the Library Living Lab

Social Challenges	Actions	Returns
<ul style="list-style-type: none"> <li>• The library as a meeting point</li> <li>• Link between physical and digital documents</li> <li>• Interaction between galleries, libraries, archives, and museums (GLAM)</li> <li>• (Re-)valorization of digital collections</li> <li>• Definition of the role of mobile technologies</li> <li>• Novel paradigms of education in open environments</li> <li>• Opportunities related to 3D printing</li> <li>• Collaborative creation: novel paradigms of storytelling</li> </ul>	<ul style="list-style-type: none"> <li>• Design, implementation, and validation of a software tool</li> <li>• Definition and implementation of the dynamics of a fortnightly activity</li> <li>• Set up of a citizen science experiment</li> <li>• Assessment of a novel methodology</li> <li>• Creation of an autonomous working group around a collective project</li> <li>• Definition of a prototype validation experience</li> </ul>	<ul style="list-style-type: none"> <li>• An open source software application</li> <li>• A new permanent activity</li> <li>• A new service for the Library Network</li> <li>• An enriching cultural experience</li> <li>• An object (physical or digital) of collective creation</li> <li>• A novel methodology or protocol</li> </ul>

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5. *Scientific experiments*: aim to advance novel models of participative citizen science.
6. *Workshops for Social Innovation*: seeks to root the dynamics of creativity and participation at a local level.
7. *Historical Images of the Neighbourhood*: makes digital collections of public archives and collections available to citizens using new tools to access and view multimedia content.
8. *Nature in HD*: explores how to give value to photographic exhibitions with contributions from users by linking physical photographs with digital content.

The next section expands on three of these illustrative examples of prototypes (both products and services) co-created at the Library Living Lab: The Library Visits the Museum, I Am my Own Drawing, and the Interest Group on Educational Apps. For a full list of the prototypes and activities, please visit [librarylivinglab.com](http://librarylivinglab.com).

### *The Library Visits the Museum*

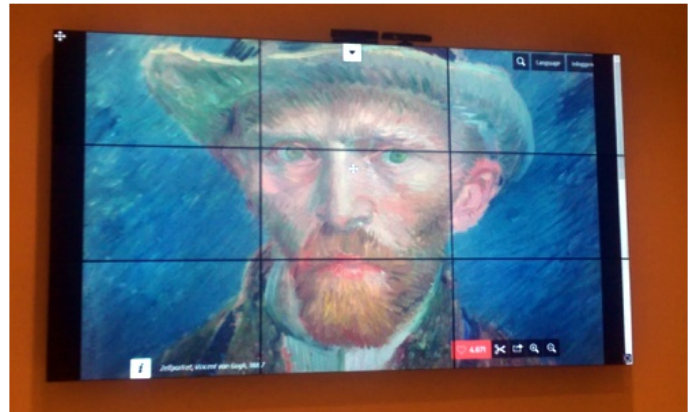
**Challenge:** Breaking down the walls between museums and libraries and (re-)valorizing digital collections.

**Action:** Design and implementation of tools, protocols, and activities for access to digital collections of museums.

**Return:** A prototype service: “The Library Visits the Museum”.

This fortnightly activity gathers users interested in learning about the contents of large and small museums that have diverse digitized their collections and made them accessible online. It begins with a selection of the museum that is going to be visited. The library staff responsible for the activity prepare a file with the historical and artistic context of these museums. Each museum is then analyzed in terms of technical possibilities and the best form of interaction is determined based on the capabilities of each museum: pictorial analysis is possible when HD items can be visualized in large-screen format (Figure 1); analysis focused on the physical spaces is an option when a realistic representation of the rooms exhibiting the collections is accessible; the study of the architecture of the building hosting the museum becomes a relevant option when it is possible to navigate into a virtual space, etc. In particular, the analysis considers the potential for direct inter-

action through the presence of human avatars (Bertrand et al., 2014) to perform a visit, which is relayed over the Internet to the library users, who can guide the visit from the Library Living Lab physical space. The result of this experience is a prototype service that is dynamically updated each session based on the lived experiences, by adding new tools and by identifying the dynamics and the minimum requirements necessary to implement such a service.



**Figure 1.** The Library Visits the Museum: An initiative of the Library Living Lab

### *I Am My Own Drawing*

**Challenge:** New paradigms of storytelling.

**Action:** Programming of new software and definition of the dynamics of a workshop for collective creation.

**Return:** An open source software application with Creative Commons license. A workshop for the children of the community. A digital story created in a collaborative way.

The current library service, “Story Time”, is a series of scheduled 1-hour sessions during which a storyteller who relates a tale to a group of children, sometimes using some theatrical interaction. Next, the children collectively create their own script of a story, for which they then draw their own characters and scenarios, which will be digitized under the supervision of a library activity instructor. The children then stage their own collaborative story performance, which is displayed on a large screen with digitized scenarios and characters. By using gesture detection technology, the movements of the children are translated to the characters shown on screen in order to animate them, thereby



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transferring the children's gestures to the digitized characters (Figure 2). The story is recorded and it becomes part of the catalogue of collaborative stories. This experience is innovation to a previously existing non-digital service.

### *Working Group on Educational Apps*

**Challenge:** Defining the role of mobile technologies in educational settings, both regulated and unregulated.

**Action:** Assess the most relevant apps and collect a set of good practices.

**Return:** Novel learning paradigms for schools and unregulated educational environments using mobile technologies.

A group of users consisting of a number of teachers from different schools in Sant Cugat and other library users interested in mobile technologies gather fortnightly to present a selection of mobile apps used in their teaching experiences (Figure 3). The goal is to gather not only the technical issues but also the methodological aspects associated with the mobile learning activities. One of the outcomes consists of the definition of the indicators of an evaluation grid suitable for educational environments, and the assessment of each app regarding the defined grid. The result is a new shelf in the library, in this case a software shelf, focused on educational tools with valuable feedback provided by critical stakeholders. In this way, the library becomes a repository of apps that provides added value that is not available in existing repositories and app stores.

### The Transformative Value of the Living Lab in the Library

The existence of the living lab enriches the daily life of the library. The continued presence of people with various profiles – scientists, artists, entrepreneurs, etc., all of whom are also “new” library users – provides novel entry points for knowledge and potential opportunities for multidisciplinary interchange among all participants, starting with the library users and finishing with the professionals who provide the services. There is also a direct impact in terms of inclusion: the new range of experiences broadens the scope of the library users, even by attracting people who otherwise would not visit the library, and by increasing the possibility of user participation in joint projects with rich profiles.



**Figure 2.** I Am My Own Drawing: An initiative of the Library Living Lab



**Figure 3.** Working Group on Educational Apps: An initiative of the Library Living Lab

At the institutional level, the presence of this genuine innovation ecosystem effectively implements the role of public space as a meeting place for all stakeholders. This ecosystem also draws small and large companies into the public and cultural sphere and promotes their participation in public initiatives. The local library expands its area of action, and this allows multiple projects of not only local but also regional and international reach. The library is thus transformed into a place where every day, something that was not planned can happen, not as a result of improvisation but of a collaborative work ensemble, with models more open and flexible programming.



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## Conclusion

Our experiences with the Library Living Lab, as presented in this article, allow us to identify some of the most relevant near-future challenges arising in the context of this innovation initiative. These challenges serve as a starting point for the reflexion on the “library of the future” and they were selected to be part of the white book for the main directives on Future Public Libraries by the Barcelona Provincial Council (Vilariño et al., 2016):

1. The Library of Living Lab was born from a citizen initiative. It will be important to implement social monitoring tools to identify these kinds of initiatives, and also to accompany them with dynamic instruments for the implementation of viable innovative approaches. The current processes of public administrations are not adapted to the flexibility needed, and it is necessary to develop methodologies of interdisciplinary work in inter-institutional teams, particularly when hosting citizen participation. This will imply a higher exposure and visualization of the performance and responsiveness of public institutions, which should be channelled in an efficient way.
2. In the medium term, the design of public spaces should be transformed into a community project: social actors must be able to participate in the design process in order to make it their own. Participation in the process of defining spaces not only ensures technical optimization based on good design, but also fundamentally integrates a project space within the community.
3. New paradigms of collaboration among all actors of society necessarily imply the need for specific models of sustainability. Novel instruments for co-financing from private patronage and sponsorship within the public space must be investigated to enable quick response at the budgetary action level for innovation projects.

4. Citizen participation in the processes of innovation opens up many questions related to management of intellectual property rights and exploitation of emerging innovations. These issues can only be solved, given their high degree of complexity and peculiarities, on a day-to-day basis. We must therefore identify monitoring and protection mechanisms of the innovation outcomes, which must become play a paramount role in the innovation processes.

In short, the fundamental challenge of innovation spaces such as the Library Living Lab is to facilitate, in an efficient way, the direct contribution of responsible citizens in the processes of defining and implementing new sustainable services and activities (European Commission, 2016). This will provide a value that can only be achieved from the participation of all stakeholders, and through the definition of process for effective policy making. Technology will play a very strong role as an enabling factor, but it is around people – and mainly with regards the mechanisms of individual and inter-institutional collaboration – that we are facing the most significant challenges. Only by truly engaging with the people – the users and stakeholders set to benefit from the innovation activities – can society obtain a transformative socio-economical impact from the innovations arising from these collaborative processes, such as those brought to life through the Library Living Lab.

## Acknowledgements

This article was developed from a paper presented at the ISPIM Innovation Conference in Stockholm, Sweden, June 17–20, 2018. ISPIM ([ispim-innovation.com](http://ispim-innovation.com)) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management. The authors wish to acknowledge the editor and reviewers of the TIM Review for their substantial contributions in improving the quality of the article.

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**Citation:** Vilariño, F., Karatzas, D., & Valcarce, A. 2018. The Library Living Lab: A Collaborative Innovation Model for Public Libraries. *Technology Innovation Management Review*, 8(12): 17-25. <http://doi.org/10.22215/timreview/1202>



**Keywords:** living lab, library, participatory, innovation, cultural spaces, public spaces, technology

# Exploring the Use of Stakeholder Analysis Methodology in the Establishment of a Living Lab

Marius Imset, Per Haavardtun, and Marius Stian Tannum

“*Interdependent people combine their own efforts with the efforts of others to achieve their greatest success.*”

Stephen Covey (1932–2012)  
Professor and author of  
*The 7 Habits of Highly Effective People* (1989)

This article explores how to conduct a cost-effective stakeholder analysis to investigate opportunities and interest in establishing a living lab for an autonomous ferry connection. Using an action research approach, we share our experiences with the process and results, and we reflect openly on the strengths and weaknesses of both the stakeholder methodology generally as well as our own implementation specifically. According to the cyclic nature of action research and experiential learning, the research was conducted in two iterations, with the second iteration drawing upon input from the first. We compare and discuss these two approaches in terms of costs and benefits from a practitioner’s perspective. The article provides a contribution to stakeholder analysis methodology for complex, multi-stakeholder innovation initiatives, such as living labs.

## Introduction

Unmanned vessels are now fast turning from vision to reality (Øvergård et al., 2017), and the first autonomous commercial cargo ship, the Yara Birkeland, is scheduled for service in Norway in 2020 (Skredderberg, 2018). Informed about these developments, the public authorities in the Norwegian municipality of Tønsberg organized, in 2016, a dialogue meeting including industry and other stakeholders, aimed at replacing the existing 12-person ferry called the “Ole 3” (Figure 1), with a new environmentally friendly and autonomous ferry, named the “Ole 4”. The idea and process were well received but did not result in any follow-up projects from Tønsberg municipality.

However, the process sparked further interest among a group of faculty members from the maritime and engineering departments at the University of South-Eastern Norway, who are the authors of this article. We obtained, in 2017, funding for a small follow-up project with a focus on navigational risk analysis related to automation. The comfort and safety of the passengers, as well as other nearby vessels and people, is paramount both in regular service and in case of incidents and emergencies. As part of the risk analysis,

some interviews were conducted with the end users, including the ferry operator and passengers. However, in order to pursue the development of an autonomous ferry, including systematic involvement of end users, relevant organizations, and industry, a larger project based on more formalized collaboration would be needed. In order to prepare the ground for such an initiative, we decided to use an open innovation approach (Chesbrough, 2006; Tanev, 2011) and started to search for a specific methodology.



**Figure 1.** The “Ole 3” 12-person ferry (Photo by Tønsberg Sjømannsforening, used with permission)

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The quadruple-helix model (Arnkil et al., 2010; Miron & Gherasim, 2010) describes how industry, universities, users, and public organizations can work together to create a fruitful environment for innovation. According to De Oliveira Monteiro and Carayannis (2017), the linkages between these four sectors are indispensable for boosting innovation and productivity growth. The living lab methodology (Keyson et al., 2017; Ståhlbröst, 2008) implements a quadruple-helix model into an operational arena for innovation and provides a set of concepts, guidelines, and tools to help practitioners establish and organize these links into co-creation processes.

We chose to apply to the living lab methodology presented by Robles, Hirvikoski, Schuurman, and Stokes (2017) as the basis for an initiative with the goal of establishing a living lab around the Ole 3 ferry, and potentially other ferries as well. Living labs are concerned with generating value and benefits, in particular for end users, but also for the wider set of stakeholders. According to Logghe and Schuurman (2017), involving stakeholders is likely to encourage positive perceptions of the process and improve the quality of output and results. Stakeholders are “any group or individual who can affect or is affected by the achievement of the organization’s objectives” (Freeman, 1984), so the task of identifying, understanding, and involving all relevant stakeholders in complex quadruple-helix environments may be quite costly, while the benefits, in particular in early phases, is uncertain. The use of panels has been presented as one useful method to handle stakeholders (see, for example, Schuurman & De Marez, 2012), but the applications seem to be restricted to processes focusing on end users. Although end users represent a central stakeholder group in a living lab, we found support in the literature that other parts of the quadruple helix may be more important, in the earliest stages, to the chances of success (Jonker & Foster, 2002; Savage, 1991). Also for living lab development, Schuurman (2015) emphasizes the importance of approaching the establishment of a living lab from the “macro” perspective, with a particular focus on the organizational level.

### Research Problem

A broad stakeholder analysis appears to be a central and critical activity in the early stages of both innovation projects in general and in the establishment of a living lab in particular before a formal project and funding are in place. However, we found that there is a lack

of practice-oriented research and more detailed guidelines on how to conduct such an analysis in living lab contexts. One practical aspect of obvious importance is the need to balance costs and benefits (Drèze & Stern, 1987). Thus, we address the following research question:

*How can a cost-effective yet valid and reliable stakeholder analysis be conducted as part of an early-stage initiative in the establishment of a living lab?*

### Methodology

Being both researchers and practitioners engaged in the Ole 3 ferry project, we have chosen to address the research problem by the use of an action research methodology. Action research is also recommended as an interesting and suitable approach to living lab research (Logghe et al., 2017; Ståhlbröst, 2008).

According to Greenwood and Levin (2006), action research is social research carried out by a team that encompasses researchers and members of an organization, community, or network that seek to improve the participants’ situation. Action research consists of a set of main tasks, which we describe below in the context of how we have addressed them in our research:

1. *Define the problem to be examined:* We (the research group/participants) met and discussed our goals and challenges, which resulted in the research problem and question described above.
2. *Cogenerate relevant knowledge about the problem:* We conducted a literature review on living labs and stakeholder analysis methodology, attended conferences, discussed the topic with other scholars and colleagues, and drew on extensive personal experience from various regional development projects. Based on this, we developed a framework for the stakeholder analysis and defined a process on how to conduct it.
3. *Take actions to solve the problem:* We conducted the stakeholder analysis and had frequent communication during the process.
4. *Collect and interpret results:* We obtained results, which we summarized in tables and analyzed.

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5. *Reflect on the process and iterate the action research cycle for increased learning:* We discussed and documented our findings, experiences, and lessons learned. As both action research and other models for experiential learning (Kolb, 2014) emphasize the cyclic nature of knowledge development, we undertook two iterations, where the first provided input for the latter.

### *Research design*

The research design is the blueprint that enables the researcher to come up with solutions to the research problem, guiding the various stages of the research (Frankfort-Nachmias & Nachmias, 2008). In our research, it implies the practical execution of the stakeholder analysis. As our basis, we have chosen the process described by Reed and co-authors (2009), which consists of the following steps: 1) Identify stakeholders, 2) Classify stakeholders, 3) Investigate the relationships between stakeholders, and 4) Reflect on the results and process.

According to the principles of action research and the nature of experiential learning, we adjusted the research design from the first to the second iteration to account for lessons learned. Thus, in the following sections, we describe each iteration, including similarities and differences in research design, as well as results and reflections according to an action research methodology.

### **The First Iteration**

In this section, we summarize the first iteration of our action research study while emphasizing relevant methodological issues and reflections. For further details of this first iteration, please see our earlier paper on this topic (Imset et al., 2018).

#### *Step 1: Identification of stakeholders*

We used the framework provided by Ståhlbröst and Holst (2012) as a starting point for describing four main stakeholder groups for living labs: companies, researchers, public organizations, and end users. We decided to limit our scope to the Ole 3 project, making this a meso-level approach to living lab development (Schoorman, 2015). As a tool in our discussion, we found the 17 stakeholder roles identified by Nyström, Leminen, Westerlund, and Kortelainen (2014) to be helpful. Examples of such roles are advocate, producer, coordinator, and messenger. Together, we generated a list of 25 stakeholders that seemed relevant for the Ole 3 project at this stage, including ourselves as the initiators of the living lab initiative (i.e., the research group), those internal to

the university and those in the external environment (private and public organizations). End users are key stakeholders in living labs, but without a common agreement with central stakeholders to commence with a living lab approach, as well as more solid funding, we found it immature at this point to start a wider involvement of ferry end users (i.e., the passengers).

#### *Step 2: Classification of stakeholders*

A classification scheme for our stakeholders and their attributes was made by combining the “rainbow diagram” (Chevalier & Buckles, 2008) with the attitude–power–influence model proposed by Murray-Webster and Simon (2005). Table 1 presents these five attributes and their definition.

Our approach to the analysis was to do a subjective evaluation internally in the research group, based on data from interviews, meeting notes, email correspondence, websites, and personal subject-matter knowledge from the Ole 3 project. For our interviews, we developed an interview guide addressing aspects related to the five attributes (Table 1). Once data was gathered, we met to rate and classify stakeholders according to Table 1.

Our findings, reflecting our own interpretation of the stakeholders, were that they generally have a positive attitude (scoring in the range of 4 and 5), but that the influence, power, and degree to which the stakeholders are actually affected, was quite low (scoring in the range of 1 and 2).

#### *Step 3: Investigation of the relationships between stakeholders*

For this step, we applied a one-directional actor-linkage matrix (Biggs & Matsuert, 1999). Reed and colleagues (2009) identify three dimensions of stakeholder relationships – conflict, complementary, and cooperation – and we chose to focus on the cooperative aspect of relationships, as we believed this was the most valuable at this stage. Then we undertook another subjective evaluation by scoring the strength of each relationship with values spanning from 1 (weak) to 3 (strong). A sample of the resulting matrix is presented in Table 2.

We found that there are significant variations in the strength of relationships between stakeholders. We also found differences in our subjective perceptions about both the nature of the relationships, as well as the relative strength of the stakeholders. Our stakeholder list contained both individuals and organizations, which added to this challenge. We recognized that relationships, even when our perspective is limited to collaborative aspects,

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**Table 1.** Stakeholder attributes and definitions on stakeholder properties

Attribute	Definition (adapted by authors)	Scale	References
Influence	To what degree the stakeholder is able to informally influence the living lab initiative	Least – Moderate – Most	Chevalier & Buckles, 2008
Degree affected	To what degree the initiative/project, and the outcome of it, will affect the situation for the stakeholder		
Power	How much power/authority is held by stakeholders of relevance to the initiative/project	Insignificant – Influential	Murray & Webster, 2005
Attitude	Stakeholders' current attitude towards the initiative/project	Blocker – Backer	
Interest	How interested the stakeholder is in the initiative/project	Passive – Active	

**Table 2.** Sample of results from relationship analysis

Stakeholder	01	02	03	04	05	06
01						
02	3					
03	3	3				
04	2	2	3			
05	1	1	2	3		
06	1	3	3		2	

contain many sub-dimensions that needed clarification in order to secure reliability and validity of this type of analysis.

## Step 4: Reflect on the results and process

As the final step, we reflected on the result and process, both individually and meetings. The results of these reflections are described in Table 3.

## The Second Iteration

Based on our experiences from the first iteration, we made a number of changes in focus areas and research design for the second iteration. One of these changes was to shift from the meso (project) to the macro (organizational) level, in line with recommendations from Schuurman (2015). With respect to defining the organizational context, we chose to focus on our internal environment at the university. This is because of the central role of universities may play as generators and facilitators of quadruple-helix collaboration (Arnkil et

al., 2010), and because we know from several years of experience that solid internal support is a key success factor in projects addressing multiple external stakeholders. During the first iteration, we also identified other projects going on among faculty, which addressed the same categories of external stakeholders. Typical for academic institutions with a high degree of individual autonomy (Winter, 2009), there was no common structure for how we should collaborate internally or with external parties in this new area of research. Thus, an internal analysis seemed necessary before moving on with external stakeholders.

Despite the common practice with third-party, subjective evaluations in stakeholder analysis, we find this approach to be doubtful in terms of both validity and reliability (Frankfort-Nachmias & Nachmias, 2008). Thus, we wanted to measure the perceptions of stakeholders themselves, rather than using our own opinion. How a person perceives their fit with their job and organization was found by Cable and DeRue (2002) to be

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**Table 3.** Lessons learned in the first iteration of stakeholder analysis (from Imset et al., 2018)

Lessons Learned	Comments
1 To list stakeholders is one thing, following up is another.	Secure time and resources, as well as good internal coordination. The creation of a living lab may need to be established as a separate, formal project with funding. Formalization may also increase understanding of the functions of a living lab and make it clearer for internal participants to understand what their roles and tasks are.
2 Start with internal stakeholders in own organization before moving external.	In a university environment such as ours, there is a plethora of related activities, projects, and stakeholders that need to coordinate in order to provide a coherent message to external stakeholders.
3 Plan and consider the first iteration of stakeholder analysis as an indication only.	Stakeholder analysis is considered to be an iterative process (Reed, 2009), and this aligns with our outcome and experiences. In terms of a living lab, we need to include end users as well, but will await this involvement until the organizational aspect is clearer.
4 Address individuals, not organizations, in stakeholder analysis.	It is ultimately people who will contribute or resist, so we found that addressing individuals was the most fruitful level of analysis. Mixing individuals and organizations into the same analysis made the work difficult.
5 Stakeholder analysis requires a clear, common understanding of classification attributes.	We developed and discussed the framework together in the research group, but should have defined the meaning of the terms more thoroughly to secure a common understanding.
6 A meso-level approach to the establishment of a living lab is challenging; a macro-level approach may make it easier.	It was difficult to isolate the project (meso) level from the organizational (macro) level when analyzing issues related to the living lab (confirming Schuurman, 2015). Thus, we believe it would have been better to start with a macro-level approach.

a better proximal determinant of attitudes and behaviours than the actual, or objective, fit. This supports the validity of data based on stakeholders' own perceptions of themselves and their relationships.

As our data collection tool, we chose to make an electronic survey. As constructs, we chose to continue with the stakeholder attributes according to Table 1, but our relationship construct applied in the third step of the first iteration needed revision.

Based on the challenges of separating the project from the organizational level in the first iteration, we also set forth to define a more focused, macro-level issue for the survey. This was of particular importance as we were to address the stakeholders directly. We also wanted to align our analysis with an ongoing strategic process on how to increase internal coordination and collaboration among faculty. Thus, we made the following introduction to the survey: "One goal in the faculty strategy is that we should improve internal communication, coordination, and collaboration. This stakeholder

analysis is initiated to support this process: how we should organize our activities, with a particular focus on autonomous shipping (including ships, ports, logistics, and operations)." Note that in the maritime domain, shipping denotes waterborne transportation of both goods and people, including ferries.

The details of these adjustments in research design is elaborated below, under each step of the stakeholder analysis process.

### *Step 1: Identification of stakeholders*

We used the same method as in the first iteration: defining a list based on our own perception. However, due to experiences from the first iteration, we now focused on people as individuals, and we ended up with a list of 13 stakeholders. Of the 13 surveys sent, 10 were returned. In order to secure anonymity, stakeholder names were replaced with capital letters. Acknowledging limitations in our own knowledge, and to obtain an increased understanding for future work, we also allowed respondents to identify new stakeholders they felt were



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relevant. Due to time constraints, these additional stakeholders did not complete the survey but were considered in the relationship analysis.

### Step 2: Classification of (internal) stakeholders

We used the same five stakeholder attributes as defined in Table 1, but added available time as a new factor. This is because time is a resource that affects most aspects of human enterprise, and therefore it is a central parameter in practical cost-benefit trade-offs (see Hollnagel, 2017, for an interesting elaboration on this). The survey contained six questions, one for each attribute, and respondents were asked to indicate their answers by use of a 5 point Likert-type scale (Table 4).

The respondents' answers were entered in the same type of spreadsheet as in the first iteration (see Imset et al., 2018, for details) and were coded with qualitative labels according to Table 5. Table 6 shows the results of

the survey, with mean score and standard deviation for each of the concepts.

We found that the interest (mean score 4.4) and attitude (4.3) among the stakeholders is much higher than their perception of what they can do to help make the desired changes (influence is 2.8 and formal power is as low as 1.8). Time seems not to be the limiting aspect, as this is rated higher (3.3). These differences indicate that, although people feel affected and interested, there may be a lack of formal or informal ways to influence in decision-making processes related to the organizational layer.

### Step 3: Investigation of the relationships between stakeholders

We continued to explore the collaborative aspect of relationships as we did in the first iteration. Human relationships may be analyzed using dozens of parameters,

**Table 4.** Stakeholder attributes and range of possible Likert-type responses to related survey questions on stakeholder properties

Attribute	Survey Question	Lowest Value (1)	Highest Value (5)
Influence	To what degree do you feel you are able to informally influence this process?	No influence	Major influence
Degree affected	To what degree do you think this process, and the outcome of it, will affect your work situation?	No change	Will totally change it
Power	Based on your formal position, how much power/authority do you have in this process?	No control	Full control
Attitude	What is your current attitude toward this process?	Totally negative	Totally positive
Interest	How interested are you in this process?	No interest	Highly interested
Time	Do you have time available for improved communication and collaboration?	No time	Time is no problem

**Table 5.** Classification labels for each attribute (adapted from Chevalier & Buckles, 2008; Murray & Webster 2005)

Attribute / Score	1	2	3	4	5
Influence	Least	Least	Moderate	Most	Most
Degree affected	Least	Least	Moderate	Most	Most
Power	Insignificant	Insignificant	Insignificant	Influential	Influential
Attitude	Blocker	Blocker	Blocker	Backer	Backer
Interest	Passive	Passive	Passive	Active	Active



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**Table 6.** Table with properties of each stakeholder

Stakeholder	Time	Rainbow Diagram		Three-Dimensional Grouping			Label			Label	
		Influence	Degree Affected	Power	Attitude	Interest					
A											
B	3	3	3	1	5	5	Insignificant	Active	Backer	Moderate Influence	Moderate Affected
C	3	1	1	1	3	2	Insignificant	Passive	Blocker	Least Influence	Least Affected
D	3	3	3	1	5	5	Insignificant	Active	Backer	Moderate Influence	Moderate Affected
E	4	4	3	3	4	4	Insignificant	Active	Backer	Most Influence	Moderate Affected
F											
G											
H	4	2	4	1	3	5	Insignificant	Active	Blocker	Least Influence	Most Affected
I	2	3	4	3	5	5	Insignificant	Active	Backer	Moderate Influence	Most Affected
J	3	3	3	2	5	4	Insignificant	Active	Backer	Moderate Influence	Moderate Affected
K	3	3	3	4	3	4	Influential	Active	Blocker	Moderate Influence	Moderate Affected
L	4	3	4	1	5	5	Insignificant	Active	Backer	Moderate Influence	Most Affected
M	4	3	4	1	5	5	Insignificant	Active	Backer	Moderate Influence	Most Affected
Mean	3.3	2.8	3.2	1.8	4.3	4.4					
SD	0.67	0.79	0.92	1.14	0.95	0.97					

but including all of these in a survey would make the survey too onerous for the respondents. As we prioritized to make the survey accessible and quick to complete, we chose to explore two central properties. The first is intensity, defined as “the strength of the relation between individuals”, and the second reciprocity, defined as “the degree to which a relation is commonly perceived and agreed on by all parties to the relation, i.e. the degree of symmetry” (Tichy et al., 1979). By means of our electronic survey, we measured the intensity of the relationship by questions addressing three sub-properties in line with Dagger and co-authors (2009): extent of collaboration, contact frequency, and motivation for increased collaboration in the fu-

ture. The three questions are shown in Table 7 along with the Likert-type scale. Frequency intervals were also added to increase reliability.

In order to condense our analysis and data, we calculated the mean value of the two first questions in Table 7 as one value for the degree of current collaboration, whereas the latter questions represent the motivation for more future collaboration. The reciprocity (symmetry) of the relationship has been calculated as the absolute value of the differences in how two stakeholders rated their common relationship. This means that the lower the calculated value, the more symmetric are the relationships.

**Table 7.** Survey questions for measuring the intensity of each relationship

Question	Low 1	2	3	4	High 5
To what extent do you collaborate today with him/her on ideation, application development, or project work related to autonomous shipping?	Less than 5 hours a year	5–50 hours a year	50–150 hours a year	150–300 hours a year	300+ hours a year
How often do you have contact with him/her in order to discuss future collaboration and ideas in autonomous shipping?	Less than once a year	1–5 times a year	5–15 times a year	15–30 times a year	30+ times a year
Based on your current working situation and knowledge, to what degree are you interested in more collaboration with him/her on autonomous shipping?	Not interested	...	...	...	Highly interested

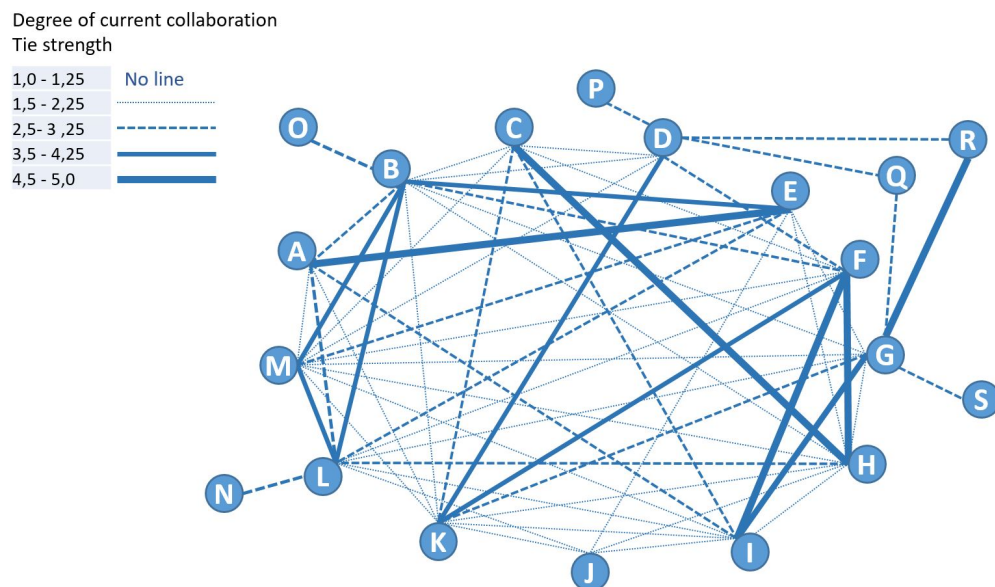
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The relational data are presented as social network diagrams (Scott, 2017) along with tables presenting more information about the nature of the relation (ties), with values for tie strength and reciprocity. Also, mean values and standard deviation (SD) were calculated. First, we present our findings for the current degree of collaboration, then for the motivation for increased collaboration in the future.

### Strength of current collaboration

We received data on a total of 82 ties, of which 44 were mutual (Figure 2). The difference in these numbers are due to the fact that three respondents did not return the survey and because some respondents added new stakeholders to the list. Details of these ties are provided in Table 8.



**Figure 2.** Social network diagram illustrating the current degree of collaboration (time spent together and contact frequency taken into account) between the stakeholders. Tie strength ranges from 1 (low) to 5 (high). The initial 13 stakeholders (A to M) are placed in a central group; stakeholders added during the survey (N to S) are placed outside the group.

**Table 8.** Overview of variation in tie strength and reciprocity in current collaboration. Mean value of all ties = 2.08; standard deviation of all ties = 1.09.

Tie Strength		Mutual Ties/Relational Symmetry		
Value	Count	Value	Count	Reciprocity
1–1.25	22	0	10	High . . . . Low
1.5–2.25	30	0.5	17	
2.5–3.25	19	1	9	
3.5–4.25	5	1.5	4	
4.5–5	6	2	4	
<b>Sum ties</b>	<b>82</b>	<b>Sum mutual ties</b>	<b>44</b>	

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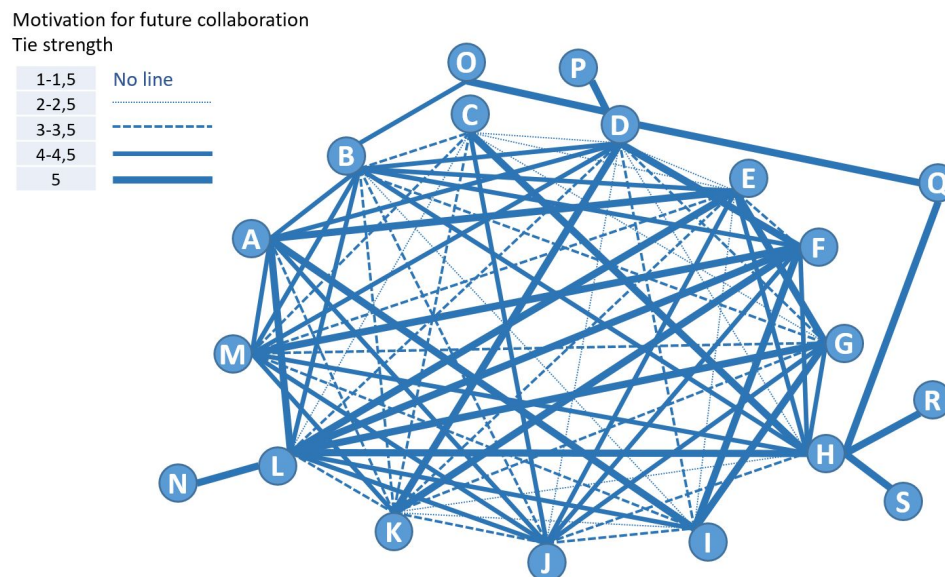
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We see that the existing network has some degree of collaboration, but most ties (42) are at 2.25 or lower (i.e., towards the lower end of the scale). The overall mean value of 2.08 is influenced by a few strong ties (11 are rated at 3.5 or higher). This is reflected in the standard deviation of 1.09. It seems as though relationships are quite symmetrical, as 27 of the total of 44 mutual ties has only 0.5 or less difference in score. However, there are also some examples of big differences, there are 8 ties with 1.5 or 2.

### Motivation for increased collaboration in the future

For future collaboration, the mean value is 3.65, which

is towards the upper part of the scale. Thirty of the 44 mutual ties have values of 1 or less, indicating a high degree of symmetry. But, there are also 4 relationships that score 3, meaning that one party is highly motivated for more collaboration, while the other is not. Lack of symmetry does thus not seem to be a big challenge, as the majority of relationships are based on mutual expectations and motivation. A high degree of symmetry was also confirmed by computing the averages of the overall received and delivered score values among the respondents, where we found only a slight difference (0.2) related to one issue (contact frequency). Details of these ties are provided in Figure 3 and Table 9.



**Figure 3.** Social network diagram illustrating the degree of motivation for increased collaboration between the stakeholders. Tie strength ranges from 1 (low) to 5 (high). The initial 13 stakeholders (A to M) are placed in a central group; stakeholders added during the survey (N to S) are placed outside the group.

**Table 9.** Overview of variation in tie strength and reciprocity for increased collaboration. Mean value of all ties = 3.65; standard deviation of all ties = 1.26.

Tie Strength		Mutual Ties/Relational Symmetry		
Value	Count	Value	Count	Reciprocity
1–1.5	4	0	12	High . . . . Low
2–2.5	12	1	18	
3–3.5	20	2	10	
4–4.5	24	3	4	
5	22	4	0	
<b>Sum ties</b>	<b>82</b>	<b>Sum mutual ties</b>	<b>44</b>	

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We also analyzed how available time may affect the degree of motivation, and we found a moderate to high correlation (Pearson=0.53). This implies that people with less time are also less interested in increased collaboration, confirming that available time is an important attribute in stakeholder analysis.

### *Step 4: Reflect on the results and process*

To us, the most interesting finding is the large difference between the current and desired degree of collaboration. Stakeholders feel that the degree of current collaboration is low, and that they would like to increase it in the future. This is promising for the establishment of a living lab. They also feel that there is time for more collaboration, but that their possibilities to influence (formal and informal power) how we work and collaborate is low. Given that the university is to become a central stakeholder in the living lab establishment, this seems to be a main barrier that needs to be

further explored. Principally there may also be other leading organizations besides the university, or the living lab may also be based on other network models (Barabasi, 2002) that are not centralized. However, to our knowledge, few other relevant internal and external stakeholders are aware of the concept of living labs, and in our region, the university would likely be expected to have some sort of hub function.

We were also surprised to see that the degree of symmetry, or reciprocity, in the motivation for more collaboration is so high, when the degree of current collaboration is low. We interpret this as an indication of general positive attitudes toward getting to know one another better. Promoting the living lab concept may help to facilitate a better understanding of how to collaborate. We provide an overview of our lessons learned from the process in Table 10.

**Table 10.** Lessons learned from the stakeholder analysis method applied in the second iteration

	Issue	Lessons Learned
1	Relevance of findings	The method revealed findings that were highly relevant and interesting to our action research context. Asking respondents themselves increases data validity.
2	The process created engagement, curiosity, and awareness in the organization	We were approached by both colleagues and managers who expressed their interest, and we expect that the results will be received with great interest by the participating stakeholders.
3	Unit of analysis in stakeholder analysis	Addressing stakeholders as individuals made it easier to work systematically (compared to the first iteration), and we also found a lot of variation within the organization.
4	Data privacy	Some respondents were very concerned about data privacy. Although we formulated our questions to address strictly professional aspects of the relationship, some of the respondents felt that data concerning relationships between colleagues was principally sensitive.
5	Anonymization	Due to ethical principles in science (anonymity), we chose to anonymize respondents. This may reduce the usefulness of the analysis in plenary discussions in the faculty.
6	Resource need for stakeholder analysis	Preparations, data collection, and analysis using this method is time consuming compared to a third-party assessment (where data is based on assumptions about stakeholder properties and relationships)
7	Limitations on the number of stakeholders	Adding a larger number of stakeholder into this type of survey, that also explores relationships, will make it hard to use in practice for the respondents. Based on feedback from our respondents we estimate that an upper limit of approximately 20 stakeholders is appropriate.
8	Keep it focused	Based on the feedback we received, we succeeded in providing a clear focus for this iteration.
9	Selection of respondents	As for the first iteration, we decided on which stakeholders to include in the analysis. In the second iteration, we allowed the respondents to add new relevant stakeholders into the survey data. We found this to be a valuable addition for follow up work.

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## Discussion

Although the first iteration followed the basic principles of stakeholder analysis, the subjective approach and an ill-defined relationship construct reduces the scientific validity and reliability. Based on our limited literature review, this seems to be a common challenge in much of the available methodology, not only for living labs, but also for the wider field of innovation.

The second iteration used methods that are more reliable and valid, and with a scope and focus that we found more useful at our current stage. The actual involvement of the stakeholders also sparked engagement. However, there are practical drawbacks with these changes, which is that the second approach required significantly more resources and expertise. Still, there is a long way to go from our simple questionnaire to a scientifically solid scale measure (e.g., exploratory factor analysis: Costello & Osborne, 2005), but such development is outside the scope of this work.

Based on our experience with project development, we find it unlikely that practitioners are willing to undertake a very extensive analysis for exploring their stakeholders (potentially with the exception of systematic user studies addressing particular issues related to the product or service being developed). Thus, a simpler approach seems needed – one that still ensures a satisfactory level of reliability and validity. The similarities and differences of our two iterations is summarized in Table 11.

## Conclusion

In accordance with methodologies for stakeholder analysis and action research, we conducted a stakeholder analysis in two iterations. We applied two different approaches in order to explore which is better in terms of costs and benefits for living labs practice. The action research has been conducted in the context of the initial phase of a living lab for increased autonomy in the maritime shipping industry. Due to the early stage of this project, we have chosen to focus on the internal organizational layer, before reaching out to external stakeholders such as industry and end users. Our research indicates that a thorough, scientifically solid stakeholder analysis provides higher value, but may be too costly or complex compared to simpler methods. We propose that our approach applied in the second iteration provide a good cost-benefit balance suited for living lab development and related open innovation initiatives.

## Acknowledgements

This article was developed from a paper presented at the ISPIM Innovation Conference in Stockholm, Sweden, June 17–20, 2018. ISPIM ([ispim-innovation.com](http://ispim-innovation.com)) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

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**Table 11.** Overview of differences in research design in the first and second iteration, including our evaluation of strengths and limitations of the two approaches

Aspect	First Iteration	Second Iteration
Living lab level addressed	Meso	Macro
Scope	Quadruple helix	Intra-organizational
Data collection method	Evaluating stakeholders (external assessment by the researchers)	Asking stakeholders using a survey (self-assessment)
Stakeholder types	Mix of organizations, groups, and individuals	Individuals only, but at different levels in the organization
Step 1: Identify stakeholders	Defined by research group/authors. In the second iteration, we allowed stakeholders to suggest other stakeholders.	
Step 2: Classify stakeholders research design	Researchers' perception of stakeholders	Stakeholders' own perception
Step 2: Stakeholder attributes	5 stakeholder attributes (Table 1)	The same 5 attributes, plus time
Step 3: Investigate the relationships between stakeholders	Researchers' perceptions of stakeholders One factor, uni-directional	Stakeholders' own perceptions; data collection by a survey Three dimensions Bi-directional
Step 3: Relationship construct	Collaboration; ill-defined	Collaboration; better defined, with sub-properties
Step 4: Reflection on the results and process	Research group only; during and after the process, individual, and in plenary	Similar as in the first iteration and also spontaneous reflections on methodology from stakeholders participating in the analysis
Reliability and validity	Low	Medium
Cost (sum of time spent from all parties)	Very low	High
Competence needed to use the method	Available to all living lab practitioners	More specialized expertise needed
Benefit from a practical perspective	Low, but useful as a trigger for more discussions and planning	High; the analysis provided more detailed and reliable insight

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- Citation:** Imset, M., Haavardtun, P., Tannum, M. S. 2018. Exploring the Use of Stakeholder Analysis Methodology in the Establishment of a Living Lab. *Technology Innovation Management Review*, 8(12): 26–39. <http://doi.org/10.22215/timreview/1203>
- Keywords:** living labs, stakeholder analysis, autonomous vessels, maritime, open innovation, action research, quadruple helix, management





# A Framework for Field Testing in Living Lab Innovation Projects

Lynn Coorevits, Annabel Georges, and Dimitri Schuurman

*“No product is an island. A product is more than the product. It is a cohesive, integrated set of experiences.”*

Donald Norman

Professor, consultant, and advocate for user-centred design

Within innovation research and, more specifically, living lab projects, a crucial component is to test an innovation in a real-life context with potential end users. Such a field test can validate assumptions by combining insights on behaviour and attitudes towards the innovation. This allows for iterative tailoring of the innovation to the needs and wants of the potential end users. Moreover, relevant insights can be gathered to stop or rescope the innovation project before big investments are made. Although studies indicate that testing innovations (or prototypes) in real-life contexts improves the innovation process, there is no specific framework on how to conduct a field test for an innovation. This is important because, in living lab field tests, users are actively involved in co-creating the solutions, which impacts the operational side of setting up living lab projects. Therefore, within this article, we propose a framework for field testing based on the degree to which it reflects reality and the stage within the living lab process. We distinguish four types of field tests: concept, mock-up, pilot, and go2market field test. Based on this framework, we propose some practical guidelines for setting up living lab field tests.

## Introduction

Since the beginning of the digital revolution and the shift towards user involvement (Ortt & van der Duin, 2008; Rothwell, 1992), the usefulness and usability of digital systems became the object of study. In the 1950s, for example, Dreyfuss (2003) highlighted the importance of “designing for people” and emphasized the importance of creating good experiences for the end user. While the focus was on user experience, the evaluations of those experiences happened in a controlled lab (Benedek & Miner, 2002). Nowadays there is an increased tendency to extend the research process beyond the limitations of the lab towards the highly dynamic environment known as “real life”. If products are only tested in a lab setting, they often fail once introduced into the users’ natural environment. The main reason is that people are known to tailor their behaviour to the setting they are in: for example, users may exhibit different behaviour with similar technology in their home or the office (Intille et al., 2003). Additionally, there is a gap between what people say and what

they actually would do (Sanders & Stappers, 2012). Furthermore, users need to have passed the “honeymoon” period (i.e., the amount of time a user needs to get to know and form an attitude towards a new technology) before they can evaluate the technology (Spohrer & Freund, 2012). In other words, studying user interactions “in situ” over a longer period of time is indispensable. The living lab community has been aware of this from day one and recommends setting up a living lab to research the appropriation of technology in the user’s daily life (Dell’Era & Landoni, 2014). By setting up a real-life intervention (i.e., a field test) and by using multi-method approach, the likelihood of generating actionable user contributions for the innovation under development increases (Georges et al., 2016). The difference between living labs and regular social studies is the participatory aspect, where co-creation is more important than merely observing users interacting with technology. As such, a field test in a living lab, compared to a traditional field test, goes beyond gathering user feedback; it encourages users to propose improvements for the technology being tested (Spohrer & Freund, 2012).

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However, the living labs literature is surprisingly silent in terms of the set-up of real-life experiments or testing. Living labs yield the greatest value when moving from concept to prototype in a living lab (Schuurman et al., 2016). Therefore, some living lab researchers and practitioners recommended defining hypotheses that can be tested throughout the entire living lab process in a real-life setting (Rits et al., 2015). These hypotheses can then contribute to the selection of research methods such as observation, experimentation, contextual interviews, etc. (Schuurman et al., 2018). But the principal challenge remains unanswered: how can these more “traditional” research methods be applied in real-life contexts and capture its dynamics? It is, for example, hard to define key settings in which tasks will be performed but also to collect qualitative data in the field (Brewster & Tucker, 2016; Coorevits & Jacobs, 2017). Thus, some academics have studied how different elements of context influence the user experience (Jumisko-Pyykkö & Vainio, 2012). Moreover, it has been demonstrated that evaluation methods such as the “think aloud” protocol need to be adapted and new methods that suit the challenges to evaluate technology in the field should be developed (Fields et al., 2007). Living lab researchers mention field tests as an approach to discover and understand how technology is appropriated in a real-life setting (Ballon et al., 2005; Følstad, 2008; Kjeldskov & Skov, 2014; Veeckman et al., 2013). Although living lab researchers refer to real-life experimentation and testing as one of the key elements in living labs, Habibipour and co-authors (2018) did not find a common definition and therefore distilled theirs from *Merriam-Webster Dictionary*, which says that the aim of conducting a field test is “to test (a procedure, a product, etc.) in actual situations reflecting intended use”.

Most living lab researchers set up a field test towards the end of the innovation process, because it is at this point in time that the technology is mature enough to let users interact with it while taking into consideration the dynamic nature of context in which it all happens. However, Lew and colleagues (2011) argue that this should not strictly be necessary and there are possible variations in terms of the “realism” of the setting. Additionally, some studies also recommend simulations of the technology (e.g., a “Wizard of Oz” approach) or the context (e.g., a lab that looks like a living room) if the technology is not yet mature enough to make field tests possible (Coorevits & Jacobs, 2017), but they did not identify a common approach towards testing.

There is a need in the living lab community to reduce the complexity of their operations and have a more har-

monious and standardized approach (Leminen & Westerglund, 2017; Mulder et al., 2008). Therefore, in this article, we seek to overcome some of the challenges related to real-life experiments and construct a framework that will encourage standardized field tests. Our approach is to use case studies to categorize field tests based on the stage of the innovation process and degree of contextual realism. The resulting framework is intended to help the living lab community maximize value from living lab processes. Accordingly, we also offer some practical guidelines for innovation practitioners.

## Field Testing within Living Labs

A living lab employs a multi-method approach, engages users, enables participation from multiple stakeholders, and operates in a real-life setting so that the different parties involved can co-create a solution (Robles et al., 2015). A study from Schuurman, De Marez, and Ballon (2016) showed that a living lab yields maximum value when evolving from concept to prototype, but if some methodological elements are missing, user contributions will be limited. This is often the case for the real-life technology intervention. The authors assign this to the lack of maturity of the innovation, making it difficult to make the evaluation realistic. Living lab researchers often only implement field tests towards the end of the development process, because they assume the complex interactions between the system, user, and environment can only be observed when the innovation has reached a certain level of maturity. The real-life aspect means the product and setting are often designed to be as close to actual usage as possible. It is very common for researchers to let users operate the technology freely and evaluate the usage via objective and subjective measurements. They do this because it enables triangulation and because real-life experience lowers the barrier for user contribution (Schuurman et al., 2016). But, when taking this into consideration towards the end of the innovation process, the need for scope change can be detected too late, leading to high development costs. Although the uncontrollable dynamics and interactions between user and system create complexity in a living lab, they also steer learning and the further development of the innovation (Leminen & Westerglund, 2017). As a solution, researchers and practitioners tried to deal with the challenge of studying complex contextual requirements in the different stages of a living lab project (Coorevits & Jacobs, 2017). Attempts were made to replicate the “wild” or real-life aspect during field tests in the early phases of the Living Lab project (Mulder & Stappers, 2009). This was done by either simulating the environment in which the interaction takes place (e.g.,

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creating a usability lab that looks like a living room) or the technology itself (e.g., a “Wizard of Oz” approach or experience-prototyping techniques) (Dell’Era & Landoni, 2014; Mulder & Stappers, 2009; Sein et al., 2011; Stewart & Williams, 2005). Replication or simulations of “real life” and “technology” in tests are accepted in the living labs literature as long as the researcher remains aware of their constraints (Coorevits, Schuurman et al., 2016). This leads to a wide array of approaches and methods being used to test innovation in the field, while the living lab community is longing for more standardization (Leminen & Westerlund, 2017). Therefore, this article will try to bring structure to the way a living lab field test can be set up.

Based on previous studies on field tests and the importance of real-life testing in early stages of the innovation process (Georges et al., 2016; Habibipour et al., 2018), we created the following definition for field tests in living labs:

“A field test is a *user study* in which the interactions of *test users* with an *innovation* in the *context of use* are tested and *evaluated*.”

Following this line of reasoning, field tests can differ in terms of the stage in the living lab process they take place in and in the degree of realism. In the following sections, we discuss both of these aspects.

## Stages in the Living Lab Process

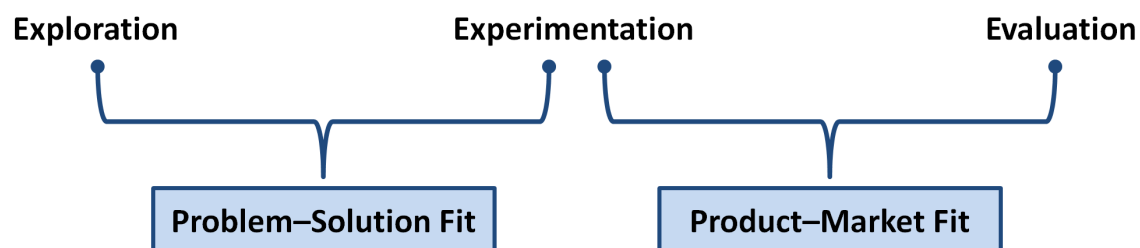
### The exploration phase

New product development (NPD) starts with a problem–solution fit stage, whereas, in a living lab, this first phase is called the “exploration phase” (Figure 1). The focus is on moving from the idea towards a concept of the solution. This requires studying the “current state” of users, identifying the problem, and trying to match a new solution to the problem while taking into account the specific contexts in which these problems occur

(York & Danes, 2006). The need–solution pairing happens by iteratively reformulating problems to discover need–solution pairs. This is done by testing a point in the solution landscape (per cycle) against a point in the need landscape for viability. The trial-and-error cycle continues until an acceptable need–solution pairing is found or created (von Hippel & von Krogh, 2013). This means that the innovation, with each step of the need solution pairing, will reach a higher level of maturity. Within the exploration phase, the maturity of the technology will be rather low, mostly including basic components of the solution. To test the problem–solution fit, we can use similar technologies (i.e., a proxy technology assessment) to learn how they currently solve their problems, which needs or problems are unresolved, and which (partial) solutions work. Although in the strict sense of the definition, these type of interventions are not with the innovation at hand, we still perceive them as a field test.

### The experimentation phase

The second stage within an innovation development process can be labelled as “experimentation” where we move from concept to prototype. In general, a prototype can be perceived as something being built to represent a product or experience before the actual artefact is completed (Sanders & Stappers, 2012). Prototypes of ICT products can have many variations, from paper prototypes, which are sketched representations of the graphical user interface, to functional prototypes that can be used on a device or features under development being mimicked (i.e., using a “Wizard of Oz” approach) allowing real-world tests (Coenen & Robijt, 2017). The form is influenced by the learning objectives with regards to the possible “future state”. Hence, their main goal is to facilitate hypothesis testing. In this stage, users are confronted for the first time with the solution, so user research mainly studies how users react to and interact with the new solution. In summary, the experimentation stage puts the designed solution to the test, as much as possible in a real-life context, and it



**Figure 1.** Overview of the NPD process and its three corresponding stages in living labs

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allows a decision to be made on whether to head back to the exploration stage to iterate the solution or whether to proceed to the evaluation stage.

## *The evaluation phase*

The third and final stage consists of evaluating the innovation in terms of market fit. Within this phase, the innovations have a rather high level of maturity. The focus is on how to enter the market, including determining which users will adopt first, how to communicate with them, and which features should be launched to maximize uptake and continued use. York and Danes (2006) refer to this as “customer validation”, which means the identification of a scalable and repeatable sales model, where the goal is to establish product–market fit and find a viable business model. A key question at this stage is: what advantages is the innovation able to deliver? This facilitates the determination of pricing levels, given that the impact of the solution can be quantified. This stage can also consist of the post-launch activities, where actual adoption and usage of the innovation is monitored in order to re-design or add new functionalities according to the needs of existing or new market groups.

Schuurman, Ballon, and De Marez (2016) showed that it is more challenging to organize a field test in the early stages of the NPD process. Extra effort and expertise are required to make the test possible. The framework in this article will help researchers and practitioners to gain more expertise on how to organize a field test in each phase of the process.

## **Degree of Realism**

The second parameter that will determine the type of field test that can be set up in a living lab project is related to context. For some innovations, a particular use context will be simulated to test the innovation. The most important thing is to determine the degree of realism (i.e., how close the test is to the actual use and context) required for an evaluation to be meaningful and which aspects of use are important enough to preserve in the evaluation setup (Coorevits & Jacobs, 2017). For example, the physical location cannot be similar to the one in which the final product will be used, the test users are not representative to real users, the tasks will not be the same, the motivations and other concurrent activities of participants are different in the test situation compared to real-life, etc. Kjeldskov and Skov (2014) as well as Korn and Bodker (2012) called for greater awareness of the trade-offs you make when simulating a context. They state that, the better the under-

standing of the context in which an activity takes place, the better the evaluation of a system. Coorevits and Jacobs (2017) provided a framework to understand context in living labs. The framework goes beyond the traditional understanding of a real-life setting (the physical environment) and highlights the importance of social, task, time, and other elements that can influence the interaction with a system. If one or some of these elements are not realistic in a living lab field test, they might also influence the outcome of the study. Unrealistic content, for example, can feel artificial to the user and can lead to atypical behaviour because they perceive the system itself as unrealistic. They might start to explore the boundaries of the system out of curiosity. If users are asked, as part of a usability test, to perform a series of tasks that are not relevant to them, this might create boredom or displeasure, which might be wrongly seen as an outcome of the study instead of the treatment, and as such it compromises the external validity of the usability test.

There are five components of context that can influence the interaction with a system:

1. *Temporal context*: the interaction of the user with the system in relation to time (Tamminen et al., 2004). Time can be simulated by giving users dedicated moments in time where they have to perform actions, by establishing the duration in which the field test takes place, etc.
2. *Physical context*: the apparent features of a situation or physically sensed circumstances in which the user/system interaction takes place (Dourish, 2004). A physical context can be simulated by making a lab look like a living room, for example, or by limiting the physical context to a certain area of the real physical context.
3. *Technical/information context*: the relationship to other services and systems that are relevant to users' systems. It also refers to the interoperability, informational artefacts, and access between devices, services, platforms, etc. Simulations can happen by mimicking the autonomy of a system or features but also the aesthetics and content available in the system.
4. *Social context*: the other people present, their characteristics, and roles but also the interpersonal interactions and culture surrounding the user systems interactions. When simulating the social context, for example, social interactions can be reduced by test-

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ing with the user alone, or users can be asked to test with a friend, family member, or colleague.

5. *Task context*: all the tasks surrounding the user's interaction with the system. Simulation of the task context means, for example, that the user is asked to perform certain tasks during the field test (Bailey & Konstan, 2006).

Although simulation of these five contextual elements and the decision to simulate particular elements while not controlling others will vary depending on the living lab requirements and as such require a custom approach, there is still a common trend. If the maturity of an innovation is high, fewer simulations will be required.

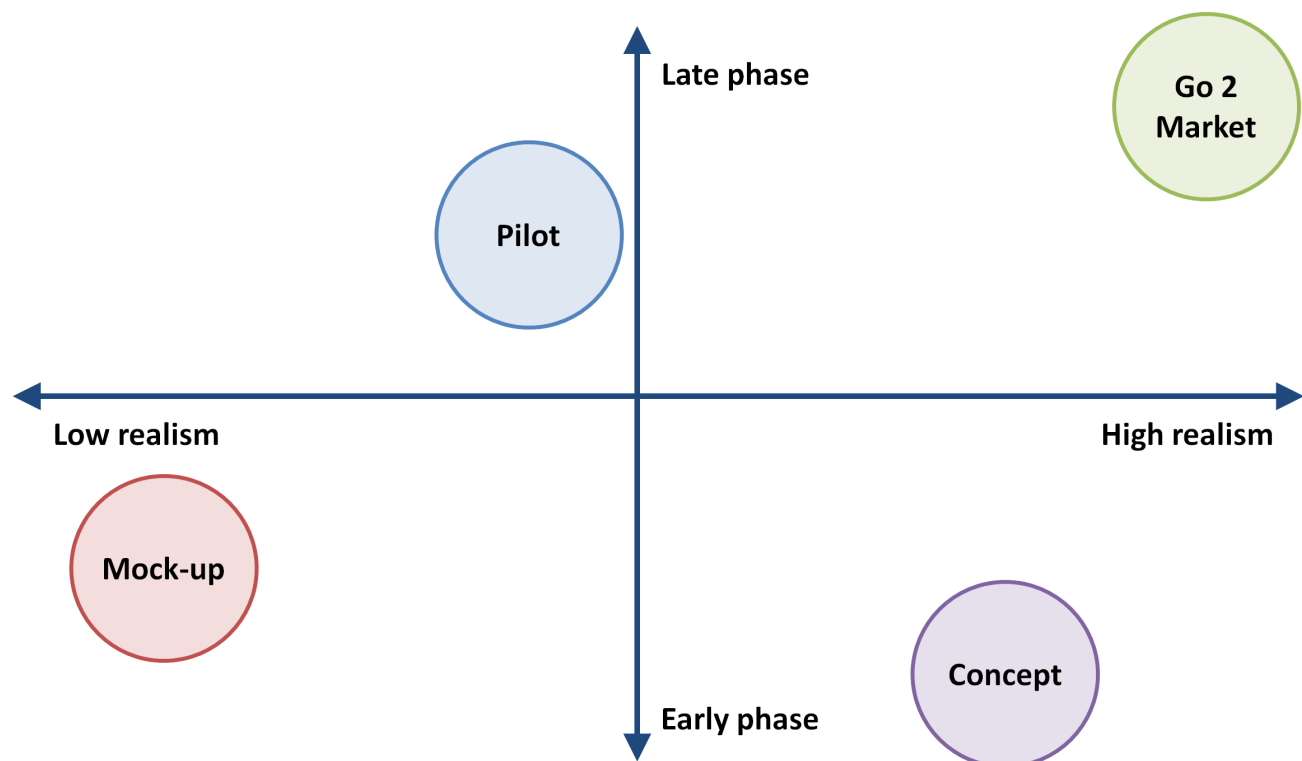
### Methodology

Based on the above elements, we composed a high-level framework composed of four quadrants along two axes: degree of realism (high vs. low) and phase in the living lab project (early vs. late). This leads to four “archetypes” of living lab field tests: low realism and early phase, high realism and early phase, low realism and late stage, and high realism and late stage. In order to validate and fine-tune the framework, we performed a qualitative multiple

illustrative case study. Yin (2009) defines the case study research method as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used”. The goal was to determine whether these four archetypical field tests could be found in living labs practice and to better understand their potential differences and value. We used action research to analyze the cases, which is particularly relevant when producing guidelines for best practices (Sein et al., 2011). We composed a sample of 17 field tests out of more than 100 living lab innovation projects from imec.livinglabs (see also Schuurman et al., 2016 and the imec.livinglabs website: imec-int.com/en/livinglabs). Out of these cases, the author team selected four field tests that best matched the four archetypes.

### Results and Discussion

In this section, we identify the four types of field tests that resulted from our coding – concept, mock-up, pilot, and go2market (Figure 2) – and describe them with illustrative case studies. We then elaborate on the operationalization of these four types of field tests.



**Figure 2.** The four types of field tests in living labs, characterized by their phase and degree of realism

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### *Concept field test*

Concept tests are, in the strict sense of the field test definition above, not a field test because the intervention happens with existing technologies and not with the innovation itself, but we include them in the model because they share other elements of the definition. Concept tests will help identify the user's problem in the early stages of new product development. By focusing on a preliminary idea and applying lightweight technological interventions that attempt to investigate current practices and experiences, the output of this test will inform the development of the value proposition the innovation should focus on. It is a good way to gather feedback before wireframes or prototypes are developed. The intention of a concept test is to evolve from idea to mock-up. They are mostly done with 5–8 people (per persona) in a real environment. An example of a concept test is the proxy technology assessment (Bleumers et al., 2010; Brown et al., 2011). A proxy technology assessment lets future users experience one or more related technologies (i.e., hardware or software) that already exist today. Crucial is that these technologies share as many characteristics as possible with the technology under development. These types of technologies are described as proxy technologies. Both the way in which the proxy technology is appropriated and the users' experience-based reflections on these technologies can be used to inform and inspire the development of new technologies in an early stage. Smoke testing will help to quantitatively validate and measure the needs, value promise, and initial interest in a product (Gothelf, 2013). The goal is to justify building the product. A smoke test is typically a one-page website describing the product or service before it is actually available. The potential customer or user is at that point in time not aware that it does not yet exist but must give some form of payment to access the product or service. Ideally, smoke tests happen in an "A/B format" that compares two or three different value promises and the potential uptake with enough users to statistically validate the results (e.g.,  $n=30$  per format).

Within our sample of field tests from imec.livinglabs, we selected NowYu. This was a project to identify how users can gain greater control over their data on social media. The project examined how and what people are willing to share as well as the value they expected in return. A proxy technology assessment was set up where we asked several users to test different data-sharing platforms. The platforms were selected in a way that we could test user preference for different potential re-

wards or values, data sharing and control mechanisms, etc. The users were given assignments, but they were free to choose whether they wanted to perform the action on the platform and when they wanted to perform it. They received screenshots of the platform on which they could write feedback related to their experiences, reasons for taking or not taking actions, etc. In other words, the degree of realism was rather high. This allowed us to create clickable mock-ups and interesting navigation flows and make decisions in relevant features to accomplish a problem–solution fit.

### *Mock-up field test*

Mock-up tests can help to gather information about the nature of the interaction and test it before the functional model is built. Additionally, they can investigate aspects of the product form such as visual affordances. These tests are especially relevant if they happen before the actual development takes place as they can guide the development in the right direction. The IEEE's report "Why Software Fails" points out that an estimated 50% of rework time could have been avoided had testing been done in the early design stages (Charette, 2005). Mock-up tests are mostly done with 5–8 people and focus on testing the intended interactions in a semi-real environment. Two examples of mock-up tests are "Wizard of Oz" and augmented reality (AR) simulations. The Wizard of Oz is a technique that enables the evaluation of an unimplemented technology by using a human to simulate the response of a system. The AR simulation can create a mock object that simulates the behaviour of complex, real objects. This is useful when it is impractical or impossible to incorporate the object in a real test. For example, when the test requires structural changes to infrastructure in a city, which is impossible.

As an illustrative case study, we chose GARbage. This was a project in which we simulated a screen on a Big Belly (this is a type of smart garbage bin) via AR. The goal was to identify how smart garbage bins could be made more interactive. The simulated screen allowed citizens to report litter or call the emergency numbers. During the field test, we simulated the technology in AR because it was difficult to make structural changes to the environment, and tasks were simulated by asking the users to walk through a given scenario while imagining them really happening because the likelihood of occurrence is rare. In other words, time, task, technical, and social context were simulated. The physical location of a city context remained natural. The test allowed us to identify a non-fit between problem and solution, as well as suggestions from participants on how to rescope.

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### *Pilot field test*

Pilot tests should provide insights into anything that might be missing in the innovation, so this can be adjusted before the complete roll-out to a larger group of test users. Pilot testing focuses on testing the entire system with a subset of users in real-life conditions and can be perceived as the dry-run test of the innovation. This should improve the likelihood of an optimized user experience. As the goal at this point is to quantitatively gain insights, involving 20–30 people will be required to statistically infer conclusions. One example of a pilot test is setting up test marketing. Test marketing is a method wherein the product is launched in a selected (geographical) area that is representative of the final market to check the viability of the product and the demand among the selected group of people. Test marketing is relevant when you decided to go to the market but, of course, the test can alter the plans by giving a no-go. In other words, this test allows testing in a real (sub) context with the minimal viable product.

iCinema was a project in which we wanted to create an application that allowed interactions via a second screen (smartphone) in a movie theatre to increase audience engagement. Because of the potential contextual barriers, we invited several users to come and see a movie. Most contextual elements had a high realism such as the people they came with, but the test was not completely natural. For example, the time and information context (i.e., the movie being played) was simulated because of the “test setup”. During the test, the movie theatre screen invited them to interact via their smartphones, while we measured not only the number of people actually interacting, but also their experiences. The outcome indicated that second-screen interaction is acceptable, but only before and after the movie, so innovations should only focus on those time periods. The outcome allowed us to make some minor tweaks and launch the application during Ghent’s film festival.

### *Go2market field test*

Go2market field tests are mostly used to validate the innovation concept when the maturity is at a higher level. The research questions are related to the product–market fit, focusing on the willingness-to-pay, retention, growth, and how to put the innovation in the market. Often, these tests will have an A/B testing scenario to estimate, for example, how new features are adopted by users and whether or not they increase retention. Go2market field tests are characterized by a high level of maturity resulting in the fact that the test can have a high degree of realism. As the goal is to make predic-

tions for the entire population, samples start at a minimum of 50 users, while experts claim that a higher rate of sampling is often even better.

SPOTT was a project in which an application was tested that allowed users to buy products being shown on television while they are watching their favourite television show. Given that the users could test the application at home during the course of a month and no instructions were given, the context was completely natural. This also implied that the content of certain television shows was made interactive, so anyone downloading the app and watching these programs could participate. The test was intended to validate learnings from previous steps and provide insights into the willingness to pay per adoption profile. The most important outcome of this test was answers to questions about how to accomplish growth and retention.

### **Guidelines for Operationalizing the Different Types of Field Tests**

The four types of tests indicate some differences in setup. The early stages of the living lab process deal with innovations that have a low maturity. Also, the degree of realism will be simulated to a greater extent. In the early stages, the focus is on validating assumptions about customer needs, on identifying target segments for a new product or idea, and on gathering insights to define an innovation with a competitive value promise.

Early-stage field tests share the following characteristics, which take the form of practical guidelines for setting up living lab field tests:

1. *Small-scale and closed:* When setting up a field test in the early stages, a smaller number of test users is needed. First of all, the input you will receive from a larger number of users is limited. Second, as most living lab researchers and practitioners operate with a tight budget, it is better to spread that budget over different steps of your iteration process. When selecting this small number of users, it is important to focus on specific user profiles or personas (Coorevits et al., 2016) to join your test. This will allow you to identify the most promising target groups, their needs, and how the innovation should be formed to reach maximum potential.
2. *Higher degree of guidance:* Because the maturity of the innovation is low and there still are many uncertainties, you will have to select the most critical assumptions or uncertainties to test in this stage of the



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process. It is about diving deeper into the habits of users while putting them in context. As a researcher, you will often spend time preparing, for example, a storyboard representing the situation and taking the user through the journey by asking the user to perform certain tasks. This means that users will be given more specific guidelines on how to test the innovation, to gain answers on your specific questions (e.g., Is the use flow correct and does it make sense? Is the design understandable?). This also means that, as a researcher, you will have to be aware of not biasing the outcome because the test will be more intrusive for the user.

3. *Qualitative:* During these early stages, we often try to answer questions that are related to the “why” and “how”, so we can find a better problem–solution fit. For example, what problems are users currently facing and how are they trying to solve them? Therefore, profound qualitative research methodologies are more appropriate. The more the innovation takes form, the higher the level of maturity and the higher the degree of realism that can be accomplished in the field tests. In this phase, research steps are focusing more on validating the assumptions and creating minor tweaks so uptake of the innovation can reach its maximum potential.

Field tests during the later stages will show the following characteristics:

1. *Large-scale and open:* As the main focus will be to validate the value promise on a larger scale, these types of field tests will include a larger group of test users in which the field test also has a more open character and everyone who qualifies can participate in the test. You will often choose a specific group of users or all users as they use the product over time. You can gain insights into bugs, issues they face while using them, or needs for further improvement. This larger group of test users is needed to get a statistical validation of the proposed innovation, potential future roadmap based on adoption potential per target group, and to operationalize the willingness to pay (De Marez & Verleye, 2004).
2. *Limited to no guidance:* As the research questions are mainly related to finding a product–market fit, the test subjects should be asked to act freely to avoid “surprises” during market launch. The main focus is to make sure your product can stand the highly dynamic contextual requirements that can function as

a driver or barrier to interactions and, therefore, the test should be as natural as possible, meaning limited involvement of the researchers and limited-to-no guidelines should be given to the users in how to test. This also implies the test is less intrusive for the user.

3. *Quantitative:* As the focus is on validation and larger user groups are involved, the methods used will be more quantitative in nature. Questions about “what” and “how many” will be answered during these field tests. Log data from the system and measurements (in the form of a survey) will take place at several time intervals or when certain events take place to learn about how users behave, their attitudes towards the technology, and their wishes about how to improve the technology towards an optimized product.

## Conclusion

Within this article, we proposed a framework for field testing based on two axes, the phase in the living lab process and the degree of realism. Based on these two axes, and by means of four illustrative case studies, we identified four types of field tests: concept, mock-up, pilot, and the go2market. The goal of this framework is to guide practitioners to set-up field tests at every stage in the living lab process. At this moment, we see that field tests are mostly used to evaluate innovations, however, we believe that conducting field tests in an earlier phase of the innovation process can help fit the solution better to the problem.

Although increasing realism is important, not all modifications can justify the needed time and resources. Therefore, we recommend using the framework of Coorevits and Jacobs (2017) to become aware of all contextual elements that might potentially influence the interaction and make trade-offs accordingly. This will allow the researcher to become more aware of bias in their study and reduce the impact on outcomes. Additionally, it will allow field tests to be set up in the early stages of development in the living lab, because it enables decisions about what to simulate, while remaining aware of the influence that non-finished or semi-real elements can have on the outcome of a test. The earlier in the development stage, the more trade-offs will have to be made, but it will allow the researcher to take into consideration the appropriation of technology sooner, and it will ultimately reduce the likelihood of product failure.

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Even though this framework can guide practitioners in setting up field tests, we are aware that other factors can influence the set-up of the field test, such as the duration of the test. This is something that needs careful consideration. It depends on the complexity of the product, but it should last until the user feels confident that they know how to use the product. Also, other elements such as learning of completely new behaviours, the impact of the innovation on the daily life, the social character of the innovation, the installation or use of specific hardware, etc. can influence that setup, and therefore further research is needed to enrich the framework.

There is also the substantial challenge of measuring the behaviour of people in a context when testing innovations. Therefore, new methods and tools such as experience sampling and wearables can contribute to study the behaviour of test users. More research is needed to determine which methods could be used best in each type of field test.

### Acknowledgements

This article was developed from work presented at the ISPIM Innovation Conference in Stockholm, Sweden, June 17–20, 2018. ISPIM ([ispim-innovation.com](http://ispim-innovation.com)) – the International Society for Professional Innovation Management – is a network of researchers, industrialists, consultants, and public bodies who share an interest in innovation management.

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**Citation:** Coorevits, L., Georges, A., & Schuurman, D. 2018. A Framework for Field Testing in Living Lab Innovation Projects. *Technology Innovation Management Review*, 8(12): 40–50. <http://doi.org/10.22215/timreview/1204>



**Keywords:** living labs, field test, user innovation, context research, testing

# Key Constructs and a Definition of Living Labs as Innovation Platforms

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*“If you want people to listen, you have to have a platform to speak from, and that is excellence in what you do.”*

William Pollard (1828–1893)  
Clergyman

Despite the growing popularity of using living labs as innovation platforms and the increasing scholarly attention toward the topic, still relatively little is known about many of their central characteristics. We use a qualitative research approach to identify key constructs of living labs and to understand how these constructs show up in the operation of living labs. So doing, we used theoretical constructs from the literature on user innovation, co-creation, and living labs to analyze a sample of membership applications to the European Network of Living Labs (ENoLL). The results from the content analysis of 40 applications revealed nine key constructs that are characteristic to living labs: 1) objective, 2) governance, 3) openness, 4) stakeholders, 5) funding, 6) value, 7) communications, 8) infrastructure, and 9) methods. These key constructs provide new insight that helps us to provide a definition of living labs as innovation platforms.

## Introduction

In today's rapidly changing world, innovation success requires group creativity that is facilitated through interactive processes (cf. Holst, 2007; Leminen et al., 2016). The use of living labs has become increasingly popular because they offer a multiple-stakeholder platform for collaborative innovation in real-life contexts (Leminen, Rajahonka, & Westerlund, 2017a). Although the roots of modern living labs are often associated with Massachusetts Institute of Technology (MIT) professor William Mitchell's real home environment for investigating the application of smart home systems in the day-to-day activities of humans (cf., Eriksson et al., 2005; Budweg et al., 2011), numerous studies refer to living labs prior the MIT's activities (cf. Følstad, 2008b; Leminen & Westerlund, 2016). However, scholars in the early days of living labs considered living labs somewhat differently from today. Leminen, Westerlund, and Nyström (2012) defined living labs as “physical regions or virtual realities in which 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.”

Since its conception, the living labs approach has evolved into many fields of research and applications. A recent study by Westerlund and colleagues (2018) found that research approaches to living labs can be categorized under seven broad topics: 1) Design, 2) Ecosystem, 3) City, 4) University, 5) Innovation, 6) User, and 7) Living lab. The seventh topic examines what living labs and their defining characteristics are, and its subtopics are focused on providing taxonomies, typologies, and categorizations. However, there is still not one commonly accepted definition of “living lab”, and many fundamental aspects of living labs remain dispersed (Westerlund et al., 2018). In particular, scholars in the field disagree on the components that make living labs both unique and similar to other innovation platforms (Anttiroiko, 2016; Dell'Era & Landoni, 2014; Leminen, Rajahonka, & Westerlund, 2017; Ojasalo & Tähtinen, 2016). Leminen (2013) argues that the lack of a proper definition is the cause of disconnected research. Hence, there is a need for research on how living labs view the essentials of their operations.

This study aims to identify the key constructs of living labs by using a qualitative research approach. We review previous literature on living labs and compare it with literature on user innovation and co-creation for

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the purpose of identifying central constructs by which living labs can be examined in terms of their defining characteristics. We use these constructs to analyze 40 membership applications received by the European Network of Living Labs (ENoLL; <https://enoll.org>) in order to reveal how the constructs show up in the operation of living labs, and we provide a research-based definition of living lab platforms. The derived constructs and the definition help us understand living labs as collaborative innovation platforms. The study concludes with implications derived from our analysis.

## Literature Review

### *User innovation*

More and more companies are shifting the task of revealing and understanding user needs to users themselves. One of the drivers is the understanding that user innovation happens anyway and is a mass phenomenon that companies should not overlook (Franke et al., 2016). By providing users with innovation toolkits and various resources, companies can outsource the innovation activity to customers and other stakeholders, and bundle these actors into the company's own product development process (von Hippel & Katz, 2002; Bogers & West, 2012). Toolkits can be introduced into user communities, meaning groups of users who share and disseminate information about a particular good (Parmentier & Gandia, 2013), and therefore put the users to work to harness new and reliable innovation (Sawhney & Prandelli, 2000).

To encourage participation and contribution, companies must support users' intrinsic and extrinsic motivations. The former is the internal gratification a member receives from working towards or achieving a goal within the community, and the latter refers to the external forces that encourage participation regardless of intrinsic presence. Extrinsic motivation includes, for example, recognition by the firm (Jeppesen & Frederiksen, 2006), peer reputation (Hertel et al., 2003), monetary incentives (Jeppesen & Lakhani, 2010), and reciprocity of solutions. In addition to motivational factors, proper leadership can steer the evolution of projects and choose the best fitting solutions. Despite hierarchical coordination possibly dispiriting intellectual creativity, such governance structure needs to be in place to allocate roles and tasks to the members (Bonaccorsi & Rossi, 2003).

A major problem companies are facing when utilizing user innovation is how to create a business model to profit from it (Franke & Shah, 2003). To this end, propri-

etary business models can attempt to solicit license agreements from the innovators (West & Gallagher, 2006). Indeed, management of intellectual property (IP) is central to controlling knowledge and determining ownership of the innovation (Bogers & West, 2012), especially given that strong IP regimes by the firm can retard the innovation spirit of the user community (von Hippel & Katz, 2002).

### *Co-creation*

Co-creation is a collaborative innovation activity that enhances both customer and company value (Schnurr, 2017). It extends the user innovation process by appropriating ideas from customers and stakeholders to enhance the product and create new experiences (von Hippel & Oliveira, 2011). Co-creation engages participants in collaboration to develop a "we" competency rather than a differentiated "you" and "I" interaction (DeFillippi & Roser, 2014; Lee et al., 2012). This means working together and consolidating resources over a network (Gassmann et al., 2010). Customers participating in co-creation may not receive direct social or economic value (Chen et al., 2012). Rather, intrinsic factors such as enjoyment (Fuller et al., 2007), a sense of belonging (Zhang, 2010), or potential career advancement (Wasko & Faraj, 2005) contribute to their participation in co-creation.

Co-creation consists of five areas: co-ideation, co-evaluation, co-design, co-test, and co-launch (Russo-Spena & Mele, 2012). Co-ideation means that members propose innovative ideas to the community, which are then discussed and refined. Co-evaluation focuses on the appraisal of the ideas; high-ranking ideas are reviewed by top management for business potential and passed onto others to determine the costs and benefits of implementation. Co-design is the implementation of approved ideas and requires resources such as toolkits and knowledge. Co-testing helps refine the new product and gain feedback before launching to market; the pre-commercialized product is tested, refined, and presented iteratively until it reaches satisfactory levels. Finally, co-launch means that the product is released to market and will have early adopters who promote it via word-of-mouth.

Lee and colleagues (2012) argue that co-creation improves the architecture of products (resulting in better quality) and lowers the costs of production. Due to the parallel nature of collaborative development (cf. Russo-Spena & Mele, 2012), the product lifecycle is shortened, allowing for faster launch and increased speed to market (DeFillippi & Roser, 2014). In addition, the diversified

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collaborative network enables organizations to become more efficient and agile for rapid scaling (Adler et al., 2011). Furthermore, co-created innovations have a lower risk of market failure because they are associated with higher customer satisfaction, positive word-of-mouth, and a lower likelihood of customers seeking out competitive solutions (DeFillippi & Roser, 2014).

### *Living labs*

The living lab is an innovation approach that benefits the creation of products and services (Liedtke et al., 2012; Veeckman et al., 2013). Building on co-creation, living labs provide physical and organizational infrastructures (Ponce de Leon et al., 2006), as well as a methodology and tools to coordinate the experimentation process within a variety of real-life environments (Almirall & Wareham, 2011; Leminen & Westerlund, 2017). Living labs are based on user-driven approach and the open involvement of many stakeholders (Nyström et al., 2014), and they engage diverse members to collaboratively undertake projects and develop and validate innovations (De Ryter et al., 2007; Leminen, Rajahonka, & Westerlund, 2017; Schuurman et al., 2011; Westerlund & Leminen, 2011). Trust between stakeholders is necessary to facilitate the equal and fair exchange of knowledge, resources, and efforts in innovation activities (Leminen & Westerlund, 2012).

Living labs give insight into hidden and identified user and consumer needs in real-life contexts (Leminen, Westerlund, Nyström, 2014; Leminen, Nyström, & Westerlund, 2015). Research on living labs analyzes and documents a broad variety of innovation and development activities with diverse stakeholders, and it investigates how living labs apply tools in different ways (Leminen & Westerlund, 2017). Information about users may be collected in general networks (Leminen et al., 2016), digital networks (Intille, 2002), or cross-border networks (Schaffers & Turkama, 2012), and analyzed to identify user patterns and opportunities (Edwards-Schachter et al., 2013; Nyström et al., 2014). Citizens are encouraged to socialize, suggest ideas, and engage in innovation development (cf., Mulder, 2012). The approach mitigates the risks associated with market commercialization (Liedtke et al., 2012) and results in sustainable value in smart and urban city contexts (Leminen, Rajahonka, & Westerlund, 2017a; Rodrigues & Franco, 2018; Tukiainen et al., 2015).

Users that participate in living labs represent various consumer groups, lead-user communities, research organizations, or employees of firms (Niitamo et al.,

2012). They may be seen both as passive and active respondents (Schuurman & De Marez, 2012) and an object for testing and feedback (Følstad, 2008a; Schaffers et al., 2007) but also subject for co-creation and co-development activities (Leminen, Nyström, & Westerlund, 2015). Thus, users may take or make roles in living labs (Nyström et al., 2014). A living lab provides resources to convert ideas of stakeholders into products and services (Leminen et al., 2012; Nyström et al., 2014). The industry partners, in turn, take on the role of developers and join living labs to access external ideas provided by the others (Leminen et al., 2012). They benefit the living lab's resources, networks, and techniques by finding opportunities and developing solutions that meet the needs of users (Leminen & Westerlund, 2012; Levén & Holmström, 2008). Finally, researchers are stakeholders who focus on the generation of knowledge (Dell'Era & Landoni, 2014), and they often support innovation and development activities (Logghe & Schuurman, 2017).

Living labs offer various benefits to participants, including networking opportunities and access to funding and resources (Leminen, Rajahonka, & Westerlund, 2017; Niitamo et al., 2012). Research conducted with living labs often yields unique knowledge that is otherwise difficult to achieve (Dutilleul et al., 2010). The living lab carries out research, development, and experimentation with products and services (Leminen, Westerlund, & Rajahonka, 2017). Thus, the living lab attempts to analyze users and co-create outcomes for the benefit of diverse stakeholders and society (Kanstrop et al., 2010; Leminen & Westerlund, 2018). Such knowledge can validate the innovation and ensure initial demand for the product prior to commercialization (Almirall & Wareham, 2011). Last, the tangible outcomes (product, services, and systems) and the intangible outcomes, activities, and values (e.g., employee support, supplier value, managerial tasks, and societal value) that help businesses to develop and support the well-being of users are part of the living lab mandate (cf. Kåreborn et al., 2010; Leminen, 2015).

### *Common constructs*

A comparison of the three reviewed innovation concepts and their underlying literature reveals that they share at least six defining constructs:

1. Stakeholders: Parties who are involved in the innovation process.
2. Objectives: The advantageous benefits of the output from the innovation process.



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3. Governance: The manner in which the decisions in the innovation process are made.
4. Tools: The resources required to carry out innovation activities.
5. Motivation: The reasons why stakeholders participate and the techniques used to promote participation.
6. Business appropriation: The direct or indirect means to capture monetary value from the innovation outputs.

## Methods

In order to understand key constructs of living labs and how they show up in the operation of living labs, we draw on the case study approach. According to Baxter and Jack (2008), case study research can facilitate the exploration of living labs, allowing for multiple facets to be revealed, especially when little is known of the phenomenon or its boundaries are unclear. The case study approach can yield theory that is unified and grounded in practice (Eisenhardt, 1989). Thus, we use case studies and content analysis of the text generated from the cases. Content analysis is a systematic technique used to evaluate qualitative content by converting textual data into a numerical form that can be subjected to quantitative analysis (Wolfe et al., 1993).

This research was limited to the qualitative data extracted from 2011/2012 ENoLL membership applications, which consisted of: 1 Australian, 4 Belgium, 2 Colombian, 1 German, 1 Danish, 10 Spanish, 5 French, 2 Greek, 1 Irish, 4 Italian, 2 Mexican, 1 Polish, 1 Saudi, 1 Slovenian, 2 Turkish, and 2 British datasets. Each living lab seeking to become a member of ENoLL is required to complete and submit an application form that is standardized with key questions and profile description including, for example, basic information, membership motivation, objective, key resources, degree of openness (intellectual property rights), user involvement policy, value to stakeholders, future plans, metrics, etc. We narrowed the dataset from 332 cases down to 40 by focusing on living labs that had both an application and a profile completed. First, we prepared detailed write-ups of cases (within-case analysis) to summarize relevant information. Then, we used content analysis on the write-ups to find themes. For content analysis, we conducted manual pre-editing of the data to simplify sentence structures into singular context phrases and convert words into clearly defined nouns.

We developed the coding rules used to observe the units within the text by constructing an Excel macro formula: [=OR(IF(ISNUMBER(SEARCH("KEYWORD", A2)),1,0))]. This macro was used to group phrases based on the specified keyword. A group termed OTHER was added to each search to highlight phrases that were not categorized and to highlight phrases that were categorized multiple times. Using the phrases that were categorized into their respective themes, we were able to further explain each construct's composition and count the occurrences. The enfolding literature step was used to connect the literature to the findings from the research. This step involved determining what is similar and conflicting, and why such variances exist. By making the connections, we could assure that the results are correct and descriptive.

## Results

After an analysis of the data, it was apparent that the literature-provided constructs required modification. Whereas some of the constructs found in the data were similar to the literature (stakeholders, objective, governance, methods, openness), new constructs (funding, values, communication, infrastructure) turned out to be useful in understanding living labs (Table 1). Appendix 1 (Figures 1 to 7) illustrates the relative occurrences of scope within each emergent construct.

### Objective

The studied living labs develop innovations by the communal effort of various actors (Collaboration). They prioritize teamwork and establish joint operations to mutually manage incubation space, state-of-the-art technology, and knowledge databases for optimal creativity, cost-reduction, and ecosystem. They pursue social impact on regions by improving citizen involvement in the community, developing technologies that better meet the needs, and building up urban infrastructures. Moreover, living labs offer business development to companies by creating resources and services (e.g., product research, incubation space, market trend analysis, and education). They foster employment and entrepreneurship (Economic Development), the creation of customized and holistic solutions, and the development of digital infrastructure. Lastly, living labs provide test beds and a framework for experimenting and testing products in real settings with users (Figure 1).

### Governance

It was difficult to identify a specific governance structure for living labs, but the responsibilities of governance group include: setting the lab's vision, making investment

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**Table 1.** Emergent constructs from living lab cases

Construct	Definition	Scope
Objective	The positive impact that the innovation output is expected to produce	Collaboration, social impact, business development, economic development, user impact, test bed
Governance	A structural or procedural model by which decisions for the innovation projects, process, or organization are made	Managerial process, managerial structure
Openness	Mindset of the organization that is reflected in their level of openness and collaboration	Innovation culture, intellectual property rights
Stakeholders	Entities that add value to the living lab	Participants and their role
Funding	The means by which the living lab financially supports its innovation activities	Public funding, private funding, revenue stream of living lab's business model
Values	The benefits the stakeholders gain from their membership and participation within the living lab	Product outcome, social value, business development, validation, resources, networking, knowledge, investment, and marketing
Communication	The channels, technology, and techniques used to network stakeholders for information exchange	Online presence, media presence, person-to-person interaction
Infrastructure	The necessary resources and specialized equipment required to carry out the innovation activities	Software tools, hardware, sensors, facilities
Methods	The procedural steps used for the inception, development, and deployment of innovation	Attracting participants, ethics, motivational rewards, user support, data collection, idea generation, design, testing, and commercialization

decisions, managing IP, organizing activities, appointing roles, maintaining living lab infrastructures, and planning research. The governance group ensures that the activities meet the goals by monitoring the performance of the living lab. They take on the administrative and managerial work. The governing group is also responsible for the project-level decisions. They select the projects to pursue and assign the appropriate members to oversee and run the activities and create user-centric research methodologies. The legal forms of living labs in their respective order of highest occurrence are: private, public-private partnership, public-private-people partnership, public, and undefined (Figure 2).

## Openness

The methods of managing IP in living labs are: consortium agreement, OEM, licenses, open source, case-by-case, law, and other. Living labs set forth rules and regulations regarding the use, sharing, and licensing of IP prior to the initiation of a project within the consortium

agreement. The agreements can outline the distribution of cost and gains for each member depending on their role and investment in the developments. These set of rules must be signed by all members. Living labs can also give the originators (OEM) full rights to determine the extent of the IP's usage or to manage IP for each project between the participating members. The innovation culture in living labs encourages collaborative work to achieve innovation and other goals. Thus, living labs ensure that the members respect one another and share knowledge. They reduce barriers through free access to knowledge and use open standards to enable integration and access to free tools (Figure 3).

## Stakeholders

Stakeholders could not be efficiently analyzed because the data were not properly formatted for content analysis in this respect. However, subjective review of the cases suggested the diverse involvement of companies, universities, unions, governments and public bodies, financiers, civic organizations, and associations.

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### *Funding*

The majority of funding in living labs comes from government grants and private investments. In addition, consulting provides revenues when the living lab receives payment for services rendered to third parties. The services offered in living labs vary because each living lab has a different focus. Living labs offer consulting including digital marketing, data collection and analytics, training, and product evaluations. Moreover, living labs produce income from their outputs in the form of royalties and sales. However, the members only make a profit when they succeed in the commercialization of the products. Living labs also lease their resources such as facilities and equipment to third parties for event purposes, lab research, or development (Figure 4).

### *Value*

Living labs offer various benefits to their members: business development, knowledge, resources, networking, validation, marketing, social value, and investments. Supportive activities aid living lab members to achieve business goals (Business Development). Members benefit from management support, advisory teams, project development, other member's experiences/expertise, and education. Members can take advantage of living lab's research facilities, incubation space, technologies, and knowledge content. Members can make new connections to access new industries or markets. Through the structured process that enables collaborative work (Framework), living labs help accelerate the development of products at low cost, higher quality, and establish an initial market presence. Their associated activities and ecosystem create visibility for members' brands, and add legitimacy to members' businesses (Figure 5)

### *Communication*

Two-way communication aims at achieving open dialogue for collaborative work in living labs, and helps for brainstorming ideas and gaining feedback from members. Living labs also need to consistently update the members of their progress and ongoing activities. Living labs use communication for self-promotion to brand, legitimize, and gain public recognition. Furthermore, the technology used for communication serves as management tools, for example, a database for hosting shared content, tracking project tasks, and collecting and appraising ideas. Figure 6 shows the online, media, and in-person modes of communication.

### *Infrastructure*

Living labs have five types of infrastructure necessities: facilities, networks, hardware, software, and sensors.

Again, the data were not properly formatted in order to codify and illustrate the infrastructure in our case living labs. However, all examined living labs appear to have facilities, dedicated or shared, to host in-person activities such as events, workshops, and testing in a test-bed. Facilities are either owned by the lab or a stakeholder who permits their use. Information technology infrastructure (networks) includes servers used to host the web technologies and data that facilitate collaboration. Hardware, software, and sensors vary from lab to lab depending on their intended use. In particular, sensors are used within the test environment for observing user behaviour and collecting usage data.

### *Methods*

Living labs gain users from associations, events, and random sources such as hot-spots or housing authorities. Before their involvement, the living lab informs the users of their role and project objectives, and gain written, voluntary consent. Using lead users as influencers, and with extrinsic rewards, the living lab motivates the users to contribute to the project. The living lab also provides training and tools. During the idea generation, the users and other members discuss problems, brainstorm solutions, and set initial requirements. Universities and small companies often convert the requirements into designs and prototypes. Under the guidance of research experts, the solutions are tested with users in real-life environments where data is collected through monitoring technology, digital activity logs, and surveys/interviews. Academics then analyze the data to understand the impact of the solutions. Living labs often leave the commercialization efforts to companies but can use its ecosystem and experts to promote and adopt the solutions (Figure 7).

## Conclusion

The nine constructs (objective, governance, stakeholders, openness, funding, value, communication, infrastructure, methods) provide a multi-faceted perspective to understanding living labs. Although such constructs could be considered common to innovation platforms in general, they provide a thematic perspective to examining and describing living labs that could be later compared to other innovation platforms. Using the constructs, we can now define living labs in a new manner:

*"A living lab is a sociotechnical platform with shared resources, collaboration framework, and real-life context, which organizes its stakeholders into an innovation ecosystem that relies on representative governance, open standards, and diverse*

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*activities and methods to gather, create, communicate, and deliver new knowledge, validated solutions, professional development, and social impact."*

The new definition of living labs differs from the well-accepted definitions in the literature, for example, that of Leminen and colleagues (2012) but warrants itself on three rationales. First, the new definition explicitly conceptualizes nature of living labs as *sociotechnical platforms* including *shared resources*, *collaboration framework*, and *real-life context*. The study proposes that living labs blossom or build up within a sociotechnical platform, assuming shared resources and collaboration (framework), which is realized in the chosen real-life environment. Second, the new definition assumes that a living lab organizes stakeholders and innovation activities into an *innovation ecosystem*, thus such innovation ecosystem may incorporate a high diversity of active and passive stakeholders, innovation structures, and networks. Third, the new definition broadens the outcomes of living labs from new technologies, services, products, and systems to *new knowledge*, *validated solutions*, *professional development*, and *social impact*. The definition explicitly incorporates also the sparsely discussed perspective of innovation, namely the intangible nature of innovation outcomes such as professional development and social impact in living labs. New knowledge refers to identified problems, ideas for solutions, novel information, content generation, and (scientific) discoveries. Validated solutions include the co-creation, testing, and validation of solutions.

At the same time, we reckon that one must exercise caution with the new definition. A recent literature review of living labs by Westerlund, Leminen, and Rajahonka (2018) applied topic modelling on a set of 86 living lab publications between 2011 and 2017 in the *Technology Innovation Management Review*, and identified various research perspectives on living labs. In this process, certain constructs of living labs surfaced upon the interpretation of the results. Conversely, the present study analyzed a sample of European Network of Living Labs (ENoLL) membership applications from 2011–2012, tapping into the key constructs that living labs reflect in their self-assessment. Thus, our analysis underlines the self-claimed nature of the identified constructs, and it stresses that they are crucial for living labs upon starting the operations and pursuing ENoLL accreditation. However, such constructs may not come up similarly in more established living labs or when the profiling description of a living lab is written by a researcher, as

evidenced by the extant studies (cf. Leminen, 2013; Leminen, Turunen, & Westerlund, 2015; Leminen & Westerlund, 2012; Leminen, Westerlund, & Nyström, 2012).

Although the new definition of living lab platforms is based on an analysis of how living labs describe themselves in public documentation, it is a significant contribution to the current literature. The study provided further knowledge of the constructs that give rise to the definition. That is, common constructs drawn from streams of innovation-related literature (i.e., user innovation, co-creation, and living labs) that are associated with living labs were only partially supported by the empirical study. For instance, the empirical study revealed nine key constructs as opposed to six derived from the literature review, and only three of them matched perfectly. Moreover, the study revealed communication as an important construct that previous research has not emphasized (cf. Mulder et al., 2008).

Surprisingly, the study did not highlight stakeholder roles, user engagement, and real-life contexts as the key constructs of living labs (cf. Leminen et al., 2015a; Nyström et al., 2014). This may be related to the fact that applications reflected an early stage of living lab activity, and that the study searched for common aspects within the three literature streams, whereas real-life context is a unique aspect of living labs. That said, the present study helps researchers, entrepreneurs, and managers understand the advantages of living labs (business development support, access to resources and partnership networks, as well as product ideas, validation, and commercialization), and join a living lab that provides a particular benefit. Finally, stakeholders may look at the implications of each construct and theme to form living labs that best suits their goals and is aligned with their society/stakeholders to optimize their innovation process.

Limitations of the research included a restricted number of analyzed cases due to resource constraints and the fact that we narrowed down to 40 applications using strict criteria. A larger dataset could refine the discovered constructs as descriptors of living labs and lead to a more detailed explanation of the results. It may be argued that the sample of European Network of Living Labs (ENoLL) membership applications from 2011–2012 may be too old to analyze the construct of living labs. However, based on our best knowledge, the literature on living labs does not provide evidence that the recent living labs (as reflected in applications) would be significantly different from the previous ones

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by their maturity or their knowledge levels; this is no doubt given that many of such living labs are only starting their operations and lack first-hand experience. Hence, more research would be needed to examine whether there may be differences between a new dataset and the 2011–2012 dataset used here.

Interpretation of the data is dependent on the researchers' understanding of the subject. Thus, content analysis was used to limit the bias of human interpretation. However, codifying a semantic category counter based on the frequencies of occurrences is difficult due to the diversity of the cases. Data that are nouns, such as names, require additional work to determine their equivalent pronoun (e.g., user, designer). This problem occurred for the infrastructure and stakeholder constructs. This issue may also be related to the fact that we were unable to identify living labs where users are in a dominant role (cf. Leminen, 2013; Leminen, Rajahonka, & Westerlund, 2017). The data requires extensive formatting prior to analysis, which means heavy investment of time and effort.

We propose the following future work to be done: 1) the discovered constructs could be confirmed using a larger set of data, 2) future researchers could focus on the individual constructs to deepen the knowledge of living labs, 3) the constructs may be applied to other innovation concepts to examine unique patterns in those concepts, 4) further studies are needed to reveal typical living lab constructions, both mature and existing living labs but also recent living labs that are applying for their accreditation, 5) additional studies are needed to show relative importance and relationships between the suggested constructs in the diversity of living labs, and 6) other types of data should be incorporated to avoid cause-and-effect problems associated with analyzing characteristics of members based on their membership applications.

### Acknowledgements

This article was developed from a paper presented at Open Living Lab Days ([openlivinglabdays.com](http://openlivinglabdays.com)) in Istanbul, Turkey, August 25–28, 2015. Open Living Lab Days is the annual gathering of the global living lab community.

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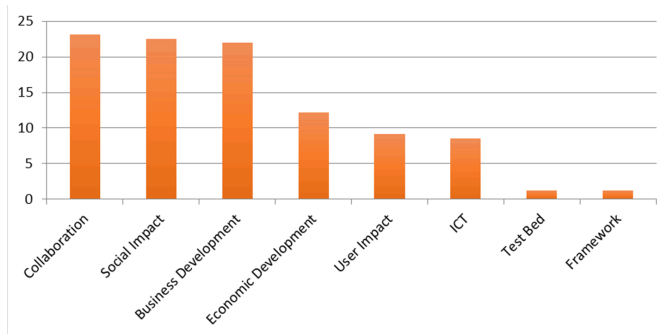
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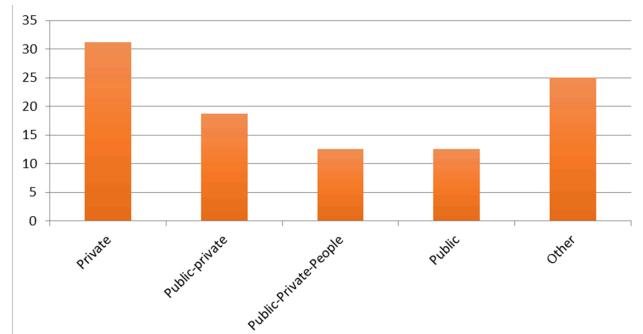
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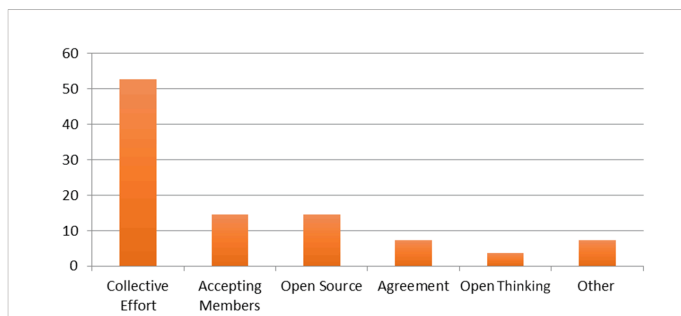
## Appendix 1. Illustrations of the Results



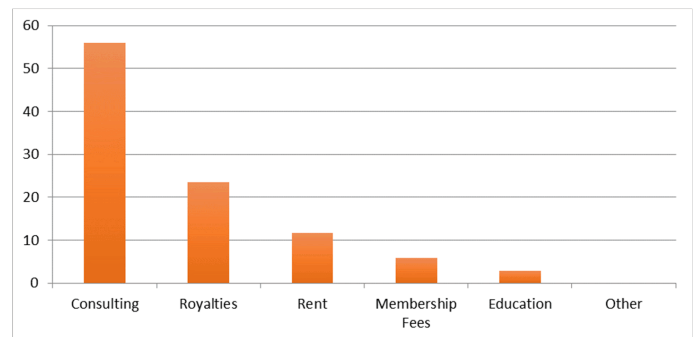
**Figure 1. Objective**



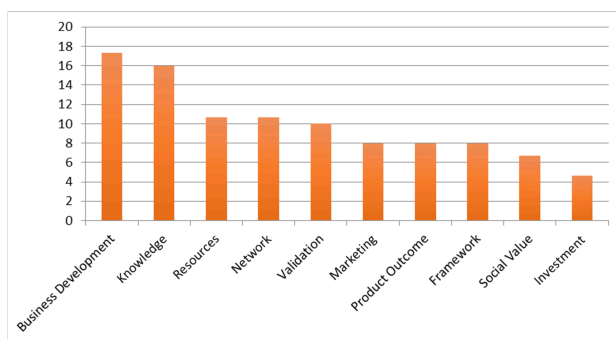
**Figure 2. Governance**



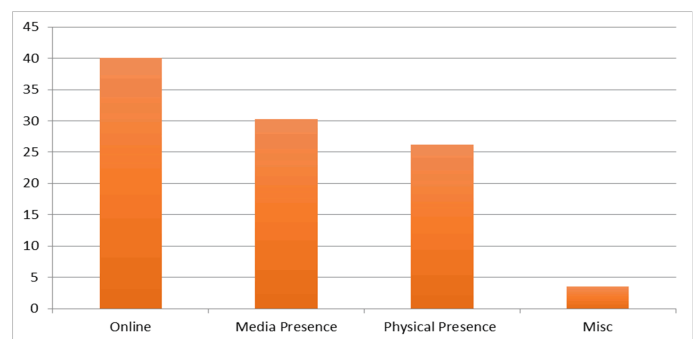
**Figure 3. Openness**



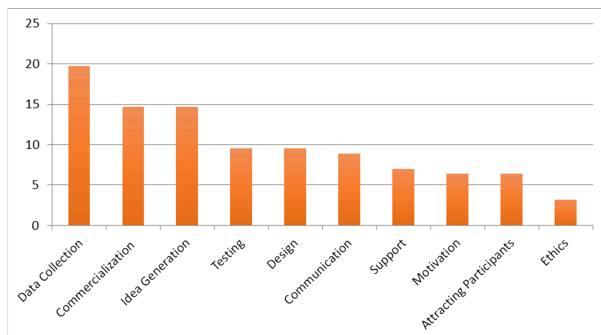
**Figure 4. Funding**



**Figure 5. Value**



**Figure 6. Communication**



**Figure 7. Methods**

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**Citation:** Westerlund, M., Leminen, S., & Habib, C. 2018. Key Constructs and a Definition of Living Labs as Innovation Platforms. *Technology Innovation Management Review*, 8(12): 51–62.  
<http://doi.org/10.22215/timreview/1205>



**Keywords:** living labs, innovation, platform, definition, constructs, ENoLL

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