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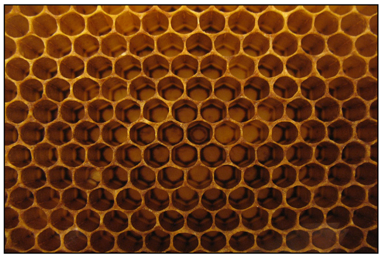

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Innovation in Living Labs

Welcome to the January 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.

Carleton University

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Overview

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 to suggest themes and nominate authors and guest editors.

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Contribute to the TIM Review in the following ways:

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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), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: Innovation in Living Labs

Chris McPhee, Editor-in-Chief

Dimitri Schuurman, Pieter Ballon, Seppo Leminen, and Mika Westerlund, Guest Editors

From the Editor-in-Chief

Welcome to the January 2017 issue of the *Technology Innovation Management Review* – the first of two issues on the theme of **Innovation in Living Labs**. It is my pleasure to introduce our guest editors: **Dimitri Schuurman** (imec and Ghent University, Belgium), **Pieter Ballon** (VUB, Belgium), **Seppo Leminen** (Laurea University of Applied Sciences and Aalto University, Finland) and **Mika Westerlund** (Carleton University, Canada).

This issue is actually our sixth devoted to the topic of living labs, and we have also published a "Best of TIM Review" ebook (amzn.to/1T7obql) of selected articles commemorating the 10th anniversary of the birth of the living labs movement in Europe. The previous five issues are listed below:

- **Living Labs: September 2012** (timreview.ca/issue/2012/september)
- **Living Labs: November 2013** (timreview.ca/issue/2013/november)
- **Living Labs and Crowdsourcing: December 2013** (timreview.ca/issue/2013/december)
- **Living Labs and User Innovation: December 2015** (timreview.ca/issue/2015/december)
- **Living Labs and User Innovation: January 2016** (timreview.ca/issue/2016/january)

We hope you enjoy this issue of the TIM Review and will share your comments online. In February, we will publish the second of these two issues on Innovation in Living Labs, which will be followed by one of our regular issues in March.

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) with potential article topics and submissions.

Chris McPhee
Editor-in-Chief

From the Guest Editors

We are delighted to start a new year of the Technology Innovation Management Review with the first of two special issues on the theme of Innovation in Living Labs. The majority of the articles featured in the issue were selected, reviewed, and revised papers presented at the Open Living Lab Days 2016, held from August 23 to 26 in Montreal, Canada. Since 2011, this yearly gathering, organized by the European Network of Living Labs (ENoLL; openlivinglabs.eu) has brought together living lab practitioners to engage in dedicated research days, with the diversity and quality of submissions increasing every year. The articles in this issue reflect the latest scholarly evolutions within the living labs movement and within ENoLL.

Living labs remain a dominantly European phenomenon, but year after year, more living labs from other continents join ENoLL. Currently, 20 percent of active living labs are non-European. The fact that the Open Living Lab days were hosted for the first time outside of Europe is another sign of this evolution. This geographical spread is also becoming visible in terms of research, as evidenced by these special issues including an article originating from outside Europe (Australia). Also, the November 2016 issue of the TIM Review featured a Canadian living labs article (Guimont & Lapointe, 2016), and research from a living lab in Asia was presented during the Open Living Labs Days in Montreal, indicating an expanding trend of living labs beyond Europe.

Besides geographical diversity, there is also increasing diversity in terms of topics covered and approaches taken in living labs practice and research. Whereas the early living labs literature focused on living lab definitions and descriptions of (best) practices and the living lab contexts, the current research is more diverse and looks into various aspects and implementations of living lab activities and the conceptualization of innovation in living labs (e.g., Bergvall-Kåreborn et al., 2015; Leminen, 2015; Ståhlbröst & Lassinantti, 2015). Attention has shifted from the "what" to the "how", with attention on different methods and tools and identifying relevant and similar innovation approaches in order to

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advance the thinking and conceptual foundations of living labs (e.g., Dell'Era & Landoni, 2014; Schuurman, 2015; Veeckman et al., 2013).

There is also an increase in quality in terms of scientific value, which is enabled by the capability to study living lab activities over a longer period of time, given that some of the pioneering living lab organizations have now been operational for more than 10 years. Historically, over 400 living labs worldwide received the ENoLL quality label, of which a core of 150 initiatives is active at the moment. This churn rate indicates a certain degree of maturity and realism within the living labs movement. In terms of Gartner's hype cycle (wikipedia.org/wiki/Hype_cycle), we might have passed the peak of inflated expectations and are moving from the trough of disillusionment towards the slope of enlightenment with the more mature and sustainable living lab organizations paving the way for new initiatives in other regions and domains.

The articles in this special issue can be regarded as supporting evidence, including research positioning living labs against other innovation methods and approaches and studies that shed more light on living labs methodology, toolsets, contexts, and their conceptualizations.

The first article is by **Dimitri Schuurman** from imec.livinglabs and Ghent University, Belgium, and **Piret Tõnurist** from Tallinn University, Estonia. They plead for greater interaction and knowledge exchange between different innovation approaches. Being both at the forefront of living labs and innovation labs research respectively, the authors merge their insights into an overview of antecedents, definitions, and research on both concepts. Based on the analysis, they propose a collaboration model between living labs and innovation labs in order to foster and facilitate public sector innovation.

The second article is by **Seppo Leminen** from Laurea University of Applied Sciences and Aalto University, Finland, and **Mika Westerlund** from Carleton University, Canada. They focus on innovation methodology as well as utilized tools and methods in living labs. Based on an investigation of over 40 living labs in ten countries, they discovered that the innovation methodology can be linear or iterative, and that the toolset can be fixed or tailored. As a result, they propose a new typology of living labs, including linearizer, iterator, mass customizer, and tailor – the last type having the greatest potential for radical innovations, while the other categories mostly result in incremental innovations.

In the third article, **Lynn Coorevits** from Ghent University and **An Jacobs** from the Free University of Brussels (VUB), both of whom are also from imec.livinglabs in Belgium, dig deeper into one of the key characteristics of living labs: the real-life context. There is surprisingly little research available on how to capture and study this context in living lab projects. Based on a literature review and a case study, the authors generate a practical framework that enables the evaluation of context from the front end of design onwards.

The fourth article is by **Tanguy Coenen** and **Sarie Robijt**, both from the Free University of Brussels (VUB) and imec.livinglabs, Belgium. They also introduce and merge other innovation perspectives and approaches within living labs. In this article, they look at agile methods that enable the translation of unintended and unforeseen requirements into technology development. These agile methods lack user focus, which is a cornerstone of living labs. Therefore, the authors combine the principles and characteristics of both approaches into a Framework for Agile Living Lab projects (FALL). The article also proposes actor roles to make the framework directly actionable in living labs practice.

Finally, the fifth article, contributed by **Rens Brankaert** and **Elke den Ouden**, both from Eindhoven University of Technology in the Netherlands, looks at the role and implications of design thinking in living labs. Based on a multi-case study applying the action research design in the domain of dementia, they propose that introducing design thinking in living labs will increase their potential to tackle so-called wicked societal problems.

In summary, the articles in this special issue illustrate that living labs is a blossoming research domain. The first, fourth, and fifth articles introduce innovation approaches, methods, and insights in living labs, enriching the outcomes and increasing the possibilities of living labs. The second and third articles contribute insights on living labs methodologies and tools, and they further our overall understanding of living labs.

We hope that you will enjoy reading this special issue on Innovation in Living Labs and that the ideas and insights foster follow-up research from living lab researchers and general innovation researchers alike. Equally, we hope the articles will inform and inspire living lab practitioners as well as general innovation practitioners. As living lab practice is built on co-creation and collaboration, we believe these principles should also be followed in living lab research, and that this is the only way forward for the living labs movement.

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Editorial by: Dimitri Schuurman and Pieter Ballon
Co-Guest Editors: Seppo Leminen and Mika Westerlund

About the Editors

Chris McPhee is Editor-in-Chief of the *Technology Innovation Management Review*. He 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. Chris has over 15 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.

Dimitri Schuurman is the Team Lead in User Research at imec.livinglabs and a Senior Researcher at imec – MICT – Ghent University in Belgium. He holds a PhD and a Master's degree in Communication Sciences from Ghent University. Together with his imec colleagues, Dimitri developed a specific living lab offering targeted at entrepreneurs in which he has managed over 100 innovation projects. Dimitri is responsible for the methodology and academic valorization of these living lab projects and coordinates a dynamic team of living lab researchers. His main interests and research topics are situated in the domains of open innovation, user innovation, and innovation management. His PhD thesis was entitled *Bridging the Gap between Open and User Innovation? Exploring the Value of Living Labs as a Means to Structure User Contribution and Manage Distributed Innovation.*

Pieter Ballon is the Academic Lead of imec.livinglabs, the International Secretary of the European Network of Living Labs, and Director of the research group imec-SMIT at Vrije Universiteit Brussel in Belgium. He specializes in business modelling, open innovation, and the mobile telecommunications industry. Formerly, he was Senior Consultant and Team Leader at TNO. In 2006–2007, he was the coordinator of the cross issue on business models of the Wireless World Initiative (WWI), which united five integrated projects in the European Union's 6th Framework Programme. Pieter holds a PhD in Communication Sciences from Vrije Universiteit Brussel and a MA in Modern History from Katholieke Universiteit Leuven.

Seppo Leminen holds positions as Principal Lecturer at the Laurea University of Applied Sciences and Adjunct Professor in the School of Business at Aalto University in Finland. He holds a doctoral degree in Marketing from the Hanken School of Economics and a doctoral degree in Industrial Engineering and management in the School of Science at Aalto University. His research and consulting interests include living labs, open innovation, value co-creation and capture with users, relationships, services and business models in marketing, particularly in Internet of Things (IoT), as well as management models in high-tech and service-intensive industries. Results from his research have been reported in *Industrial Marketing Management*, the *Journal of Technology and Engineering and Management*, the *Journal of Business & Industrial Marketing; Management Decision*, the *International Journal of Technology Management*, the *International Journal of Technology Marketing*, the *International Journal of Product Development*, and the *Technology Innovation Management Review*, among many others.

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 current research interests include open and user innovation, the Internet of Things, business strategy, and management models in high-tech and service-intensive industries.

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Keywords: living labs, user innovation, open innovation, agile methods, innovation labs, innovation management, innovation tool, conceptualizations

Innovation in the Public Sector: Exploring the Characteristics and Potential of Living Labs and Innovation Labs

Dimitri Schuurman and Piret Tõnurist

“ Policy doesn’t move as quickly as innovation happens. ”

Suzan Kay DelBene
Politician, executive, and management consultant

Living labs and innovation labs share many common traits and characteristics. Both concepts are linked to the public sector, and both concepts can be regarded as coping mechanisms to deal with contemporary changes in the innovation landscape and within society as a whole. Both build on past initiatives and practices, but are also struggling to find their own clear identity and “raison d’être”. Because both concepts are largely practice-driven, their theoretical underpinnings and foundations are mostly established after the fact: making sense of current practice rather than carefully researching and planning the further development. However, despite their similarities and common ground, most researchers treat living labs and innovation labs as separate literature streams. Here, starting from a review of the current issues and challenges with innovation in the public sector, we look for links between both concepts by analyzing the current definitions, the predecessors, and the “state of the art” in terms of empirical research. Based on these findings, we summarize a set of similarities and differences between both concepts and propose a model towards more collaboration, mutual exchange, and integration of practices between innovation labs, which can be regarded as initiators of innovation, and living labs, which can be regarded as executors of innovation. Thus, we add to the conceptual development of both concepts and propose a roadmap for the further integration of both the theory and practice of living labs and innovation labs.

Introduction

In the private sector, the rapid development of technology has provided opportunities for firms to launch new products, transform their production processes, and do business in new ways. Different paradigms and frameworks have been developed to assist private organizations in dealing with innovation, such as open innovation (Chesbrough, 2003), (lead) user innovation (von Hippel, 2005), and distributed innovation (Sawhney & Prandelli, 2000). This new perspective has led to different innovation management approaches and organizational forms to cope with these new innovation models.

These new approaches have also been introduced in the public sector. In the private sector, innovation is regarded as essential for the survival of organizations, whereas public sector innovation has long been regarded as a contradiction in terms. Borins (2002) mentions three main issues why public sector innovation may be viewed as an oxymoron: i) public sector agencies are usually monopolies, with no competitive pressure to innovate, ii) the “fishbowl management” effect (where the media and opposition forces are constantly pursuing the exposure of public sector failures) is a powerful impediment to innovation, and iii) public sector organizations are usually large bureaucracies structured to perform their core tasks with stability and consistency, fostering resistance to change or disruption of these tasks. Therefore, public organizations are mostly characterized by a culture of risk aversion and a focus on short-term delivery pressures (Mulgan & Albury, 2003). However, in recent years, this vision has

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shifted. For example, Mazzucato's (2015) work on the entrepreneurial state has normalized ideas that the public sector – through active innovative agencies such as DARPA in the US Department of Defense (financing the seeds of the Internet) – can create new markets. Furthermore, public sector innovation agencies can "de-risk" private sector innovation activities (Mazzucato 2016). Consequently, in more recent literature, such as seen in a review by De Vries and colleagues (2016), there is consensus that innovation should be a core activity of the public sector.

Nevertheless, many examples of transformative innovations used by Mazzucato and others to legitimize the public sector have found their success outside of the sector and mostly more coincidentally than in a strategic manner. Thus, in line with many public sector innovation scholars, Bommert (2010) claims that there is a need for a new form of innovation inside the public sector itself because bureaucratic (closed) ways of innovating do not yield the quantity and quality of innovations necessary to solve emergent and persistent policy challenges (Borins, 2014). Modern debates on how to organize innovation in the public sector outline the importance of public sector entrepreneurs, boundary crossing networks, empowerment of citizens, and experimental policies – these are issues for which traditional bureaucracies are not well equipped. For better results, open, collaborative innovation with stakeholders beyond government is needed (e.g., Bommert, 2010). However, how to solve these issues and practically organize this process in the public sector has received less attention in the academic literature.

Therefore, within this article, we will introduce and discuss two contemporary innovation approaches with links to public sector innovation: living labs and innovation labs. Both are linked to open and user innovation (Schuurman, 2015; Tõnurist et al., 2015), but they also seem to be mainly practice driven and are sometimes used interchangeably. Therefore, we will investigate the definitions of both concepts, their main predecessors and the research that has been carried out with regards to their characteristics and outcomes. This will enable to compare both concepts, illustrate similarities and differences, and propose a theoretical and practical link between both, as their respective literature streams have been strictly separated until now. Finally, we propose a model that integrates both into a more longitudinal vision on public sector innovation.

Living Labs

Definition

Living labs refer to user-centered, open innovation ecosystems based on a systematic user co-creation approach integrating research and innovation processes in real-life communities and settings (Ballon & Schuurman, 2015). Leminen (2013) defines living labs as: "physical regions or virtual realities, or interaction spaces, in which stakeholders form public–private–people partnerships (4Ps) of companies, public agencies, universities, users, and other stakeholders, all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts". This definition is complemented by Schuurman (2015), who sees living labs as an organized approach (as opposed to an ad hoc approach) to innovation consisting of real-life experimentation and active user involvement by means of different methods involving multiple stakeholders, as is implied in the public–private–people (PPP) character of living labs.

Therefore, living labs are both practice-driven organizations that facilitate and foster open, collaborative innovation, as well as real-life environments and arenas, where both open innovation and user innovation processes can be studied and subject to experiments, and where new solutions are being developed. This unique capability enables living labs to generate concrete, tangible innovations based on contributions from users and communities and, at the same time, to advance the (academic) understanding of open and user innovation principles and processes.

Predecessors

At least three important predecessors for the living labs movement can be discerned (Schuurman, 2015):

1. The 1970s saw the emergence of the cooperative design movement, which is related to the Scandinavian tradition of user involvement in IT design processes (Ehn, 1989). In addition to active user involvement, cooperative design also introduced the facilitation of trial-use situations as part of the design process, so as to stage users' hands-on experience with future applications, which puts the focus on the real-life context.

2. In the 1980s, the European "social experiments" with IT started (Oestmann & Dymond, 2001; Qvortrup,

1987). Social experiments originated in the field of psychology and refer to experiments taking place outside of laboratories and therefore with less physical isolation of subjects and materials, less procedural standardization, and longer-lasting treatments when compared to experiments in laboratory settings.

3. From the 1990s onwards, "Digital City" projects (i.e., digital economic development and urban regeneration initiatives) started to blossom (Paskaleva, 2011).

Towards the end of the 1990s, the proper living lab concept came into use, first in settings in the United States, which Følstad (2008) refers to as "living labs as testbeds". Soon thereafter, primarily in a European setting, living labs were more regarded as a research concept dealing with the context of the innovation, focusing on co-creation, which is in line with Følstad's (2008) second archetype: living labs for research and co-creation.

Research
Ballon and Schuurman (2015) identified a five-year gap between the first living lab projects, which were mainly funded by the European Union and started from 2000 onwards, and the first scientific publications that defined the notion of living labs (Ballon et al., 2005; Eriksson et al., 2005), which they see as evidence of the practice-driven nature of the phenomenon. Although there is now a body of literature that attempts to clarify and analyze the concept (Almirall et al., 2012; Følstad, 2008; Leminen et al., 2012), living lab practices are still under-researched, and a theoretical and methodological gap continues to exist in terms of the restricted amount and visibility of living lab literature vis-à-vis the rather large community of practice (Schuurman, 2015).

Schuurman (2015) has outlined the different layers of living labs: a macro level (the living lab organization), the meso level (consisting of living lab innovation projects), and the micro level (consisting of the different user involvement activities). Leminen, Westerlund, and Nyström (2012) distinguished between different actors in living labs: providers, enablers, utilizers, and users. They conclude that, depending on the actor that drives the living lab organization and the focus of the activities, a different "types" of living lab results, such as: i) research living labs focusing on performing research on different aspects of the innovation process, ii) corporate living labs that focus on having a physical place where they invite other stakeholders (e.g., citizens) to co-create innovations with them, iii) organizational living labs where the members of an organization co-creatively develop innovations, and iv) intermediary living labs in which different partners are invited to collaboratively innovate in a neutral arena.

This body of research illustrates the broad diversity of living lab organizations as well as innovation outcomes. It is clear that public actors are, by definition, present in the living lab organization, as implied by their PPP character, but that living lab projects deal with all kinds of innovation, consisting of active user involvement, real-life experimentation, and a multi-method approach.

Innovation Labs

Definition
Innovation labs are defined as hybrids of think tanks, digital R&D labs, social enterprises, and charitable organizations (Williamson, 2015). Their mission is twofold: to foster ICT-enabled, user-driven service production logic in the public sector as well as to cope with external changes (e.g., ICT change, austerity, demand for individualized services). Therefore, innovation labs can be defined as "islands of experimentation" where the public sector can test and scale out public service innovations. To facilitate this process, some level of autonomy is needed. Building further on this argument, Tõnurist and colleagues (2015) define innovation labs as change agents within the public sector that operate with a large autonomy in setting their targets and working methods. They are structurally separated from the rest of the public sector and are expected to be able to attract external funding as well as "sell" their ideas and solutions to the public sector. However, depending on the context, their organizational build-up can differ considerably. Innovation labs typically have relatively low budgets, are generally small, fluid organizations, and are dependent on external resources (e.g., funds, human resources) that they are able to co-opt to their activities.

Predecessors
The innovation lab as an attempt to structure (radical) change processes within public organizations is not an entirely new phenomenon: see, for example, Thompson and Sanders' (1998) work on reinvention labs in the United States in the 1990s). However, what is different in the current wave of innovation labs is their context and logic: the combination of user-driven service production logic, the ever-increasing computing

power, and fiscal austerity. One of the organizational origins of innovation labs in the public sector can be seen in the think tank culture predominant in Anglo-American politics (Williamson, 2015). As such, innovation labs have been described as purpose-driven "do tanks" (Bellefontaine, 2012). They form a loose hybrid of the think tank, the social enterprise, and the charitable organization, merged with aspects of the digital R&D lab (all of which are themselves contested, elastic, and emergent organizational forms). Broad-based characteristics of innovation labs are discussed in various reports and papers (e.g., John, 2014; Puttick et al., 2014; Tõnurist et al., 2015; Torjman, 2012; Westley et al., 2011; Williamson 2015).

Research

Although in recent years innovation labs have become relatively popular in the public sector, especially since 2010, the literature and studies on the subject are still scant. The available papers and reports remain descriptive and informative in nature; most of the provided evidence relies on insider ethnographies (e.g., Mindlab: Christiansen, 2014; Policy Lab: Kimbell, 2015) or document analyses (e.g., Williamson 2015). A report on 16 innovation labs was published in 2013 by the Parsons DESIS lab, whereas Nesta and Bloomberg Philanthropies have published a report on public sector innovation labs that covered 20 such units around the world (Puttick et al., 2014). Recently, La 27e Region (2016) mapped 78 public policy labs in European Union member states. These reports confirm the definition of innovation labs as hybrid forms.

Other efforts to analyze innovation labs include categorizing them by their segment of specialism (e.g., design-focused, psychology-based, or technology-based); by sector (e.g., healthcare or education), whether they are government-led or government-enabled or their potential level of change (incremental or systematic) (Armstrong et al., 2014; Parsons DESIS lab constellation, 2013); and based on their operations (Puttick et al., 2014; OECD, forthcoming).

However, the mentioned studies do not provide deeper insights into the way innovation labs function. Therefore, Tõnurist and colleagues (2015) conducted a detailed study, mostly based on interviews with managers from innovation labs, to examine the specific characteristics related to the envisioned outcomes and the specificities of innovation in the public sector. By having a self-generated income and low operating budgets, innovation labs do not illicit strenuous performance evaluations nor the need to collect quantitative metrics to make the output of the labs measurable. Innovation labs are relatively small and agile, forcing them to act "quick and dirty", and in this way they resemble startups. However, when projects become too big, innovation labs run against existing structures (e.g., procurement rules), which causes them to hand over the projects to other departments that can choose to continue or disband them. Stakeholder engagement and co-creation with citizens is seen as key, but the outcomes of innovation labs are produced for ministerial departments and other government agencies. A large share of the innovation lab activities is funded by the public sector, which limits their autonomy.

Tõnurist and colleagues (2015) conclude that innovation labs walk the tightrope between disrupting public organization and delivering value to their "sponsors". They do this by jump-starting and showcasing user-driven service re-design projects, specializing in quick experimentation without having the capabilities and authority to significantly influence upscaling of the new solutions or processes, focusing on prototyping without too much concern for IT capabilities. They are not yet an organic part of the public sector and its change. Their main source of autonomy and a key to their survival is high-level political and administrative support, meaning that once an innovation lab loses its sponsors, its chances of survival diminish radically. This situation highlights an interesting paradox: smaller innovation labs are easier to close down, whereas larger ones face the risk of losing flexibility and freedom to act.

Discussion and Conclusion

Within this article, we investigated living labs and innovation labs as possible solutions for public sector innovation. Both living labs and innovation labs are mainly practice-driven concepts that started to blossom around the turn of the millennium. Both can be regarded as ways of dealing with the changing environment and the changing role and nature of innovation. Table 1 provides an overview of the core characteristics of both concepts, based on the literature review above.

Both living labs and innovation labs can be regarded as practice-driven concepts that provide a more structured way to implement collaborative innovation in the public sector. There are certainly similarities and overlap between both concepts, but based on our exploratory literature review, we conclude that both are

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Table 1. Comparison of core characteristics of innovation labs and living labs

	Living Labs	Innovation Labs
Main activities	Focus on innovation development and real-life experimentation	Focus on ideation and “quick and dirty” experimentation
Organizational model	Multi-stakeholder organization	Multi-disciplinary team
User involvement	A priori user-centric	Potentially citizen-centric
Type of projects	Public as well as private sector innovation projects	Public sector innovation projects
Governance structure	More formal at the organizational level due to multi-stakeholder partnerships	More agile and volatile due to their smallness and relative independence
Operational focus	Focus on methodology and knowledge generation	Focus on problem and idea definition
Role in innovation process	Executors	Initiators

fundamentally different and can even be regarded as logical extensions of each other. The main similarities are the focus on experimentation, a strong link with ICT (both as enabler and outcome), and a collaborative, user-centric attitude. However, we also discovered major differences.

First, whereas living labs have a broader application domain and are utilized for both private sector as well as public sector innovation, innovation labs are conceived exclusively in a public sector or third sector context (especially in connection to social innovation labs). Therefore, innovation labs are slightly easier to define, whereas a definition for living labs is more elusive. However, this difference can also be due to the fact that innovation labs are much less studied compared to living labs and therefore their intricacies and differences have not been so extensively outlined.

Second, both living labs and innovation labs are multidisciplinary. However, in living labs, this mix is the result of the multi-stakeholder nature of the organization (living labs are PPPs), whereas innovation labs are smaller and consist of one team with people from different backgrounds. Thus, in public sector innovation labs, the methodologies used tend to depend on the capabilities and background of the people involved, and are not a priori citizen-centric. In living labs, the collaborative focus is a built-in characteristic of the organization.

Third, living labs are characterized by a multi-stakeholder organization set up to conduct multiple innovation projects (cf. the sustainability principle). Interdependencies between different partners make these organizations more inert. In contrast, innovation labs are smaller and more agile, but they also tend to be shorter lived. They are sometimes only operational for one or a few concrete projects, and they are highly dependent on high-level political or administrative patronage. Therefore, they are not tightly interwoven with the traditional organizational structures and are more “volatile”.

Fourth, the operating timeframes of living labs and public sector innovation labs can differ considerably. This difference is connected to the “initiator versus executor” roles of these organizations (Table 1), but the concept of a “living” lab also often infers the collection of information and feedback for innovative solutions/policy measures over a period of time in a real-life context. In innovation labs. The long-term measurement efforts are rather unique (if present at all) and concentrate on the pre-design phase in the innovation process.

Fifth, in living labs, the goal is to learn and grow as an organization by means of different innovation projects, where these projects also are more likely to cover a longer proportion of the innovation process. Innovation labs have thus far focused on the ideation and genesis stage of innovation, and then "let go" of the project afterwards. This behaviour arises because most of these organizations do not control the implementation phase of the innovations as many responsibilities can be fragmented over different public sector organizations, thus, making it time consuming for small teams to follow up on innovations.

Figure 1 proposes a model for possible collaboration between living labs and innovation labs. As illustrated, both can be seen as operating on a continuum that follows a typical innovation process from idea towards launch: living labs might be seen as the ideal structures to pick up the raw ideas or prototype solutions delivered by innovation labs, where focus can be placed on the actual implementation and execution stage, including real-life testing. Furthermore, given that innovation labs operate more in the public sector, they encounter organizational and cultural barriers that may not be present in living labs, where the partnerships between sectors are more balanced. A collaboration between innovation labs and living labs even opens up the possibility of public sector ideas being taken up by private organizations. Our model also includes a feedback loop, as the findings from the "implementation" stage carried out by living labs might be fed back to the innovation labs in order to generate new concepts and ideas. As living labs can monitor innovations post-launch, processes of re-invention can occur, based on gaps in the experience or execution. This re-invention can take place in innovation labs. However, this model is at the moment purely hypothetical; to our knowledge, no formal collaborations exist between living labs and policy labs.

Therefore, we conclude that, although they originate from different predecessors and are rooted in different research streams, both living labs and innovation labs have demonstrated their value for public sector innovation. Based on our findings, we would argue for more studies and research regarding the nature, outcomes, and possible integration of both concepts for public sector innovation, as there seems to be a lot of potential in combining both approaches as they tend to have slightly different, but complementary key characteristics. In theory, both concepts could act symbiotically to foster public sector innovation in a continuous way. Therefore we would suggest putting this hypothesis to the test by carrying out pilot projects between living labs and innovation labs. With this article, we hope to have taken the first step towards opening this new field of collaboration and investigation that has much potential to solve the specific public sector innovation challenges.

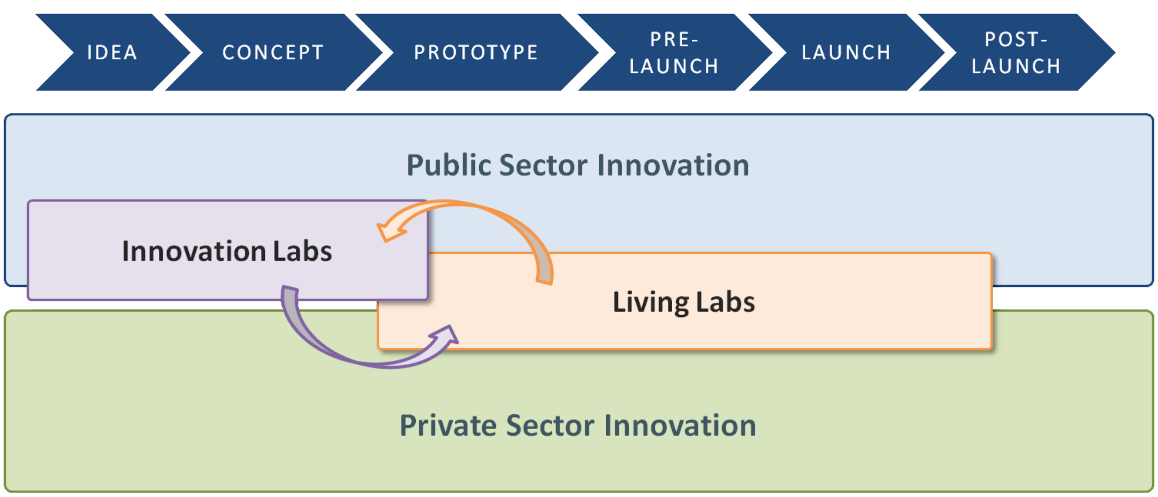

Figure 1. Possible collaboration model for innovation labs and living labs

Innovation in the Public Sector: Living Labs and Innovation Labs

Dimitri Schuurman and Piret Tõnurist

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Categorization of Innovation Tools in Living Labs

Seppo Leminen and Mika Westerlund

> *If the only tool you have is a hammer, you tend to see every problem as a nail.*
>
> Abraham Maslow (1908–1970)
> Psychologist

This article examines the link between innovation processes and the use of innovation tools in living labs. So doing, it develops a conceptual framework based on the literature to analyze 40 living labs in different countries. The study contributes to the discussion on living labs by introducing a new typology of living labs based on their innovation process characteristics and usage of tools: linearizer, iterator, mass customizer, and tailor. Moreover, it proposes three ways to organize innovation activities in living labs. The article concludes by providing a set of implications to theory and practice, and suggesting directions for future research on living labs.

Introduction

There is a need for deeper understanding of the characteristics, processes, and tools in living labs in order to integrate them with the innovation activities of organizations (Leminen & Westerlund, 2013; Niitamo et al., 2012; Sauer, 2013; Schuurman, 2015; Ståhlbröst, 2008; Tang, 2014). Although previous literature has studied living labs as a context, a methodology, or a conceptualization (Leminen, 2015), definitions of living labs commonly address the importance of the real-life environment, the involvement of multiple stakeholders, and the multiplicity of approaches (cf. Dutilleul et al., 2010; Følstad, 2008; Fulgencio et al., 2012; Leminen, 2015; Schuurman et al., 2012; Veeckman et al., 2013; Westerlund & Leminen, 2014; Leminen & Westerlund, 2016). Following our earlier definition, this study defines living labs as "physical regions or virtual realities, or interaction spaces, in which stakeholders form public–private–people partnerships (4Ps) of companies, public agencies, universities, users, and other stakeholders, all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts" (Westerlund & Leminen, 2011).

In particular, methods and tools in living labs are underresearched (Bergvall-Kåreborn & Ståhlbröst, 2009; Ståhlbröst, 2008). Many prior studies on living labs focus on development approaches in which artefacts such as prototypes of products and services are developed, validated, and tested with users and multiple stakeholders. These approaches comprise: i) methods coupled to different contexts; ii) phased, processual methods; and iii) differentiation of living labs from other R&D methodologies (cf. Almirall et al., 2012; Bergvall-Kåreborn et al., 2009: Budweg et al., 2011; Coenen et al., 2014; Edvardsson et al., 2012; Eriksson et al., 2005; Følstad, 2008; Guzmán et al., 2013; Mulder, 2012; Mulder & Stappers, 2009; Ponce de Leon et al., 2006; Schaffers et al., 2009; Schumacher & Feurstein, 2007; Ståhlbröst, 2008; Tang et al., 2012). Moreover, there are only a few attempts to investigate tools in living labs. Äyväri and Jyrämä (2015) focus on management tools for living labs, whereas Ståhlbröst and Holst (2013) and Rits, Schuurman, and Ballon (2015) advance coordination tools for iterative, phased living labs.

Given that the literature on living labs that discusses innovation tools is scant, this study identifies and distinguishes the range of tools used to support innovation in

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living labs. The study classifies tools by the type of living lab in accordance with the categorizations by Leminen, Westerlund, and Nyström (2012) and Leminen (2013). We will also offer our empirical observations on the strategies employed for confronting the issue of tools in living labs. So doing, we address the following research questions: i) what innovation tools are used in living labs? and ii) how can they be categorized?

The remainder of this article is organized as follows. First, the article reviews prior literature on living lab, develops a framework, and presents the research design and dataset. Thereafter, the study reviews the key findings of qualitative case research resulting into four new types of living labs. Finally, the theoretical and managerial implications are discussed, and avenues for future research are provided.

Theoretical Background on Living Labs

Linear and iterative innovation process

Innovation activities typically follow a linear or an iterative process. Previous literature on living labs has made numerous attempts to illustrate linear innovation process by categorizing living lab activities into phases, typically starting from an early development phase and ending with initial market activities such as a market launch (Cleland et al., 2012; Lin, Lin, et al., 2012; Vicini et al., 2012). Literature focused on the linear innovation process also discusses the set-up of a living lab (Kang, 2012; Lin, Lin, et al., 2012), the management of phases in living labs (Gong et al., 2012), and various activities in different phases of living labs (Bendavid & Cassivi, 2012; Chen, 2012; Coenen et al., 2014; Ferrari et al., 2011; Katzy et al., 2012; Lin, Wang, & Yang, 2012b; Schumacher & Feurstein, 2007; Shampsi, 2008). Katzy, Baltes, and Gard (2012) note that a linear innovation model systematically attempts to avoid or minimize interaction between the phases, whereas living labs attempt to better integrate phases by sharing knowledge. Hyysalo and Hakkarainen (2014) offer a comparison on two similar innovation projects – one a living lab project and another a conventional innovation project – and propose that the collaboration within the projects is very similar.

The iterative innovation model proposes that innovation activities are repeated rather than follow phases. Although Pierson and Lievens (2005) propose that living labs are cyclic by nature, other scholars (e.g., Bergvall-Kåreborn et al., 2009; Ståhlbröst, 2008) provide a guideline for the iterative living lab. Building on this guideline, Ståhlbröst and Bergvall-Kåreborn (2008) stress that iteration and interaction between phases foster innovation development, and Holst, Ståhlbröst, and Bergvall-Kåreborn (2010) add that openness improves and fastens innovation. Further, Tang and Hämäläinen (2014) propose a process model that has five iterative phases: requirements, co-design, prototyping, test and tracking, and commercialization. The iterative innovation model underlies the engagement of users and other stakeholders; thus, new experiences and knowledge are created by learning in innovation activities between stakeholders. Uncontrollable dynamics of everyday life are a source of complexities in real-life environments (Leminen, DeFillippi, & Westerlund, 2015), and such learning steers innovation in living labs.

Customized and standardized tools

A large body of literature on living labs refers to customized methods and tools, explaining a set of possible methods used for living labs innovation activities in different contexts (McNeese et al., 2000). Studies frequently couple different methods to real-life contexts, including e-environments, university research centres, everyday life, campuses, towns, districts, villages, rural areas, and industrial zones. For example, Bajgier and colleagues (1999) experimented with living labs in a city neighbourhood, while Benne and Fisk (2000) used a living lab as a temporary learning environment. In general, living labs focus on the development of methods and tools for innovation activities (cf. Intille, 2002; Kidd et al., 1999). Further, recent studies suggest that living labs pilot, develop, and experiment with different methods based on the results of innovation activities (Leminen & Westerlund, 2012) and that those living labs with little experience in particular attempt to develop their methods and tools for innovation (Leminen et al., 2016; Nyström et al., 2014). Mulder (2012) concludes that living labs use methods and tools heterogeneously and proposes that methods and tools should be harmonized across living labs to foster their usage.

Many studies on living labs refer to the usage of standardized, predefined set of tools in a variety of activities (Ponce de Leon et al., 2006) but do not explicitly describe them. Edvardsson and colleagues (2012) describe the living lab as a method containing many tools for customer involvement and as a context for user innovation. Furthermore, studies couple a set of methods and tools across innovation phases (Guzmán et al., 2013; Rits et al., 2015; Schaffers et al., 2009) and to five different views of living labs: user involvement, service cre-

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ation, infrastructure, governance, innovation, and outcome (Mulder et al., 2008). Budweg and colleagues (2011) argue that living labs adapt the usage of methods depending on their maturity. Thus, more experienced living labs tend to pursue standardization of the usage methods. Literature of living labs aims to create taxonomy for methods used in living labs; for example, Fred, Leminen, and Kortelainen (2011) attempt to describe the applicability of methods in living labs, and Gray and colleagues (2014) document usefulness of methodologies in different contexts. Ståhlbröst and Holst (2013), in turn, introduce a handbook for living labs methodologies for iterative and cyclic innovation activities.

Given that methods and tools are embedded in living labs and their activities, any single study cannot offer a comprehensive, all-encompassing overview of their use in living lab activities and how innovation processes are integrated into living lab activities. Therefore, the present study builds a framework (Figure 1) that has two dimensions: i) innovation process ("predefined, linear" versus "iterative, nonlinear") (cf. Schumacher & Feurstein, 2007; Ståhlbröst, 2008) and the usage of tools ("standardized" versus "customized") (Ståhlbröst & Holst, 2013). The two-dimensional framework helps to identify how methods and tools support understanding of living lab innovation activities. Also, the framework categorizes living labs in relation to innovation process (linear/iterative). It attempts to explain innovation mechanisms and outcomes in living labs rather than claiming to show any causal links or correlations between dimensions and their ends. In this article, after introducing the created framework, we use it to map and categorize innovation processes and utilized tools, and to understand innovation processes in diverse living labs.

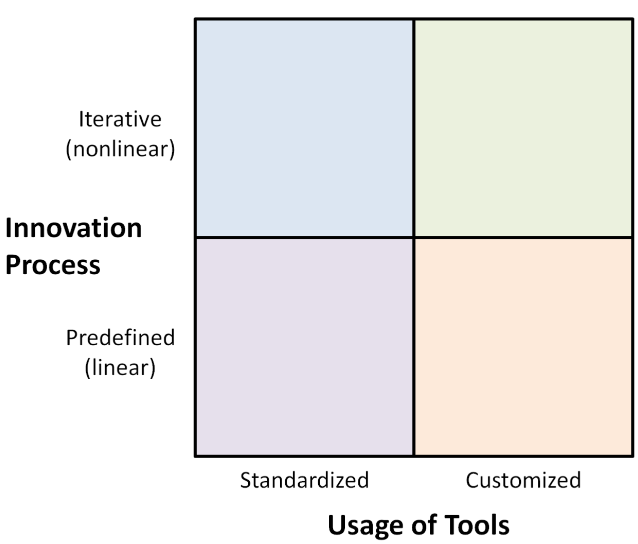

Figure 1. A conceptual framework for categorizing living labs based on their innovation process and tools

Research Design

The study utilizes a qualitative, multiple case study approach (Yin, 2003) by analyzing an international data set of 150 interviews in 40 living labs in ten countries, namely Belgium, Canada, Denmark, Finland, France, Netherlands, South Africa, Spain, Sweden, and Turkey. More specifically, the study deploys snapshot studies as suggested by Jensen and Rodgers (2001). The case selection criteria required that the living labs must innovate in real-life environments, engage multiple stakeholders, and emphasize the role of users in innovation (cf. Almirall & Wareham, 2011; Bergvall-Kåreborn & Ståhlbröst, 2009; Leminen, 2013; Leminen et al., 2014; Leminen, Nyström, & Westerlund, 2015). Furthermore, the chosen cases reflect the diversity in living labs as they were clearly driven by different types of actors (Leminen, Westerlund, & Nyström, 2012).

Data collection

The data were collected between 2007 and 2015 through face-to-face and phone interviews, which were audio recorded and then transcribed. We collected information on various themes following an interview guide (cf. Patton, 1990) and later conferred with the informants to verify the key findings. The informants include various stakeholders in living labs, including top and middle managers, scholars, project coordinators, technical specialists, and users. In addition to the interviews, we gathered secondary data from websites, bulletins, magazines, and case reports. To maintain confidentiality, the identities of the organizations and informants are withheld.

Data analysis

The empirical data were organized according to the informant, the date of interview, and the type of informant. Our study followed a multi-phased data analysis process, which consisted of open coding, focused coding, identification of innovation processes, and theorizing of codes. Table 1 gives an overview of the data analysis and the phases of the study.

In the first phase, we analyzed and coded the original transcribed interviews. The words associated with innovations processes, methods, methodologies, and tools were searched for using a content analysis technique. Following Roberts (1997) and Neuendorf (2002), the aim of the coding and content analysis was to understand the cases. The original, word-by-word transcribed empirical material was first independently coded by the authors, and later the results were jointly compared, discussed, and agreed by the authors.

Then, a second round of coding described the innovation activities, methods, and tools. This coding phase identified the standardized and customized tools in innovation activities of living labs.

In the third phase, innovation processes in the living labs were investigated. The innovation processes were coded and compared with the linear and iterative innovation processes suggested by Schumacher and Feurstein (2007) and Ståhlbröst (2008).

In the fourth and final phase, four archetypes of living labs were analyzed; in other words, we classified the cases based on their usage of tools and innovation processes (cf. Figure 1). We consider the four archetypes of living labs as one of our main findings.

Findings

This study analyzes and classifies the range of tools used to support innovation in living labs. Specific tools used for innovation in living labs include e.g. open communication and ideation tools for promoting, collecting, evaluating and disseminating contributions, as well as monitoring tools for tracking activity and individual contributions for possible legal reasons. These tools are fairly different from those used in traditional closed innovation model, in which project management tools are more efficient. The results from our analyses highlight the following four ways that tools are used in innovation activities of living labs: linearizers, iterators, tailors, and mass customizers (Figure 2).

1. Linearizers
Linearizers focus on using both a linear innovation process and a standardized set of predefined tools. This categorization is in line with prior literature on living labs, which identifies testing activities with a predefined set of methods and tools (Ponce de Leon et al., 2006). Particularly, linearizers seem to lean on a structured but linear innovation process, where the usage of standardized tools can lead to incremental innovation. This finding is in line with extant studies, which confirm that a main body of innovations are incremental in living labs (e.g., Leminen, Nyström, & Westerlund, 2015). Linearizers often represent utilizer- and provider-driven living labs (cf. Leminen, Westerlund, & Nyström, 2012), which are run by companies or organizations pursuing efficiency of operations. More specifically, the organizations aim to improve efficiency of living lab operations with standardized tools and predefined linearized processes. Developed tools cover different innovation phases and a broad variety of customer-centric and customer-driven methods. Hence, living lab activities are often productized and commercialized, and the developed generalized tools in living labs are used for the different needs of customers. And, as

Table 1. Data analysis process

Data Analysis Phase	Task	Outcome
1. Open coding	• Organize living lab cases	• Overview of living lab cases
2. Focused coding	• Identify and briefly describe innovation activities, methods, and tools in living labs	• Overview innovation activities, methods, and tools resulted in identifying opposite ends of usage tools, standardized tools, and customized tools in living labs
3. Identify innovation processes and usage of tools in living labs	• Analyze the identified innovation processes and tools • Compare data to theory	• Identification of previously identified linear and iterative innovation processes (Schumacher & Feurstein; 2007; Ståhlbröst, 2008) and predefined and customized tools (Ståhlbröst & Holst, 2013) in living labs
4. Theorizing the codes	• Synthesize phases 1 to 3	• Classification of the usage of tools and innovation processes resulting in four archetypes of living labs (cf. Figure 2)

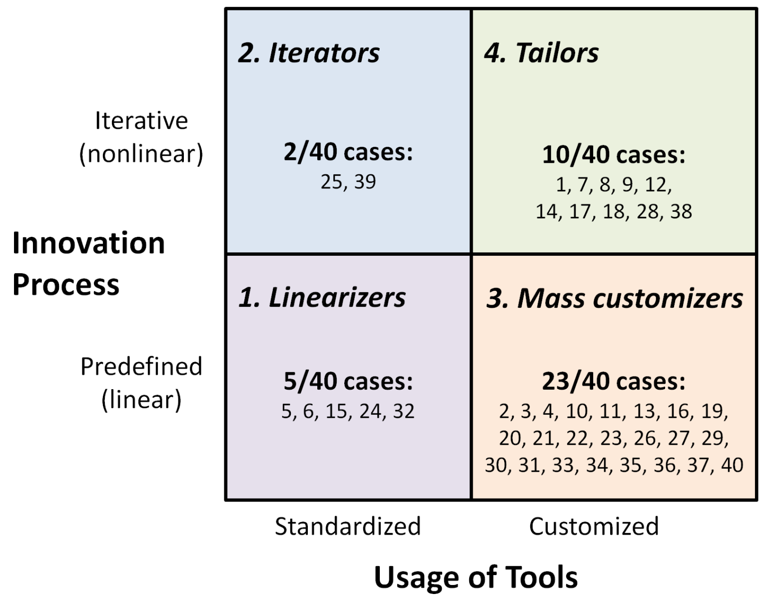

Figure 2. Case living labs categorized using the conceptual framework

an informant with design responsibility underlines, their living lab assumes a predefined linear innovation process with standardized tools in their living lab activities:

"The end of this process is testing with the users to have the experience. So, if we have the chance to have a company or public service who is coming at the beginning of the project, we could have all the steps from a real living lab, so exploration, co-creation, experimentation, evaluation. … But we have a different tool for each step. But in each tool … we have four steps; for the labour it's the same, we have different steps. And, for example, for the labour, we create them for companies to test their product with the users. And the first step is to define with the company what they need to have as information, to define with them the protocol of the experimentation, to have some papers, some tools to collect this experience, and after to analyze this information for the companies." (Case 32, Informant with design responsibility)

2. Iterators
Similar to linearizers, iterators aim to find a solution with a standardized set of tools in innovation processes. However, in contrast to linearizers, iterators adapt the innovation process based on the experiences and learning in the innovation activities. This is in a line with Ståhlbröst and Holst (2013) and Rits and colleagues (2015), who document iterative innovation process with standardized tools. In some of our investigated living labs, standardized tools were combined with iterative innovation processes, which led to incremental innovation. Surprisingly, we only found few examples of iterators (provider-driven living labs) from the sample of 40 living labs. Thus, this study speculates that many living labs have not yet adjusted their prior knowledge on innovation activities to a predefined set of tools to be used. And, as the researcher in Case 25 proposes, a living lab may assume iterative innovation process with standardized tools in their living lab activities:

"I think 80 percent of the time we don't follow the pre-determined pattern. And that's because of the input you get. So, not only do the people that come up with the innovation have to iterate, but we as researchers have to iterate and think again, this is not the best step anymore. So maybe instead of a co-creation session, for example, we should do this step now, or we should do something completely different." (Case 25, Researcher)

"We have today about 57 different methods to capture user feedback. We have the common tools like workshops and co-creation sessions and surveys and that kind of stuff. But you have also observation techniques, proxy-technology assessment tools, and whatsoever for capturing user feedback, both quantitative and qualitative." (Case 25, Business Development Manager)

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3. Mass customizers
Similar to linearizers, mass customizers adapt predefined linear innovation process; but, in contrast to linearizers, mass customizers customize their tools based on the needs in the innovation process rather than relying on the standardized tool set. The literature on living labs identifies several such types of living lab activities, where living labs aim to create a taxonomy and harmonize used methods and tools in living labs (cf. Fred et al., 2011; Gray et al., 2014). The majority of living labs seem to lean on mass customizers (Figure 2). The study identified many provider-driven, utilizer-driven, and enabler-driven living labs (cf. Leminen, Westerlund, & Nyström, 2012) as mass customizers. With mass customizers, the use of customized tools in a linear, standardized innovation process seems to lead to incremental innovation. Although the variety of tools opens up the possibility for radical innovation, the standardized innovation process restricts required innovation activities. Mass customizers reduce the variety of innovation processes by predefined linear innovation to improve the efficiency of innovation activities. However, the flexibility of innovation activities are possessed by customized tools in living labs. Mass customizers aim to find solutions for the needs of innovation activities by using predefined linear innovation process and the customized tools for innovation:

"We use methodology for user involvement and co-design, but we apply a lot of different methodology, depending on the topic of the research, for example." (Case 13, Project Manager)

"I don't like to apply the same method from one project to another. What we do in education with the remote network school, with the design experiment approach, with researchers who are familiar with research and design experiment and collecting data, sharing it, transfer it to the people on the ground to better improve the way they change their processes. That's for me the best way to organize things with the academic world and the other stakeholders and users." (Case 30, Director)

4. Tailors
Similar to mass customizers, tailors customize the usage of tools and, similarly to iterators, tailors use iterative, non-linear innovation process. We identified two groups of tailors. The first group (representing three out of ten tailor organizations: Cases 1, 8, and 9) wish to explore the possibilities of living labs. Such organizations lack prior experience on living labs or tools needed for living labs. Thus, tools are particularly developed for their purpose(s). This grouping is in line with studies of Nyström and colleagues (2014) and Leminen and colleagues (2016). In the first group, we found tailors that included user-driven, utilizer-driven, and provider-driven living labs.

The second group (representing seven out of ten of the tailor organizations: Cases 7, 12, 14, 17, 18, 28, and 38) includes living labs that have prior living lab experience, but they wish to pilot, develop, and experiment with different methods, tools, and methodologies for their purposes. This grouping is in line with the studies of Kidd and colleagues (1999) and Intille (2002). Thus, iterations of innovation activities are needed in these living labs. Also, this finding is line with the earlier study of Eriksson, Niitamo, and Kulkki (2005), which highlights the need for iterations in living labs. However, a living lab as such is the not the main focus of the innovation activities; rather, a living lab supports other innovation and development activities of organizations. In particular, provider-driven living labs represent this second group. Also, in the second group of living labs, this study identified two living labs having the development and customization of tools for the purpose of the project at hand. The usage of these tools in innovative way(s) in an iterative nonlinear process supports the emergence of radical innovations. Tailors aim to find solutions for the needs of innovation activities by tailoring the innovation process and the usage of tools for innovation.

"We need to go that area, we need to find something. So, we thought, maybe we could combine this game with some kind of media (plus) bluetooth technology. So, we set up an experiment, we tried out combinations. Also, it was with the same user group, actually, as in the previous one. And then it is really important, we always think, how will it benefit the user group? We always try to connect new stuff to the user group so they can make sense of it, they can get [something] out of it. So, we never knew this when we started. When we contacted this company, we could never say, okay, we will do this with you. Because this happens on the way. The thing we can say to them is that we try to connect your technology and your project in new situations and new companies and so on." (Case 8, Professor)

Conclusion

Theoretical implications
This study aimed to understand the range of innovation tools in the living lab context. It provides three theoretical contributions to the discussions of open innovation and living labs, and it presents new information about innovation processes and tools in living lab. First, the

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article presented a new conceptual framework for analyzing innovation processes and usage tools in living labs (Figure 1). Second, the framework distinguished four archetypes of living labs based on the innovation process and the usage of tools: linearizers, iterators, mass customizers, and tailors (Figure 2). Third, the study proposed three preliminary propositions based on the findings from the case studies (below).

This study takes a step forward by revealing tools used for supporting innovation in living labs. In contrast to other studies on innovation in living labs, which focus on explaining living labs as a methodology, this study argues that, by using appropriate tools, living labs can significantly foster the emergence of innovation. Therefore, this study contributes not only to the emerging literature on living labs by depicting fours ways tools are used in living labs, but also by proposing the ways such tools can be used to reorganize innovation more generally in the open innovation model.

Conceptual framework

The developed framework sheds light on innovation activities and how such innovation activities are coupled to the diverse living labs. The dimensions of the framework include the innovation process ("predefined, linear" versus "iterative, nonlinear") and the usage of tools ("standardized" versus "customized"). Whereas the former is inherently related to the process views, for innovation activities in living labs, the latter is grounded on the usage of tools in living labs. This study concludes that emerging living labs probably start with a customized approach to investigating the possibilities of living lab activities. However, the results of our study show that living labs aim to reduce the complexity of their operations by the standardized tools, or by standardized innovation process, or both. The standardization is often documented to reduce costs and provides cost savings (cf. Kaufmann & Eroglu, 1999). However, the present study suggests that such standardized activities seem to lead on incremental innovations in living labs thus reducing the enthusiasm of living lab activities among stakeholders. This finding is in line with prior studies that highlight the importance of passion in addition to the resources and knowledge in living lab activities (Leminen & Westerlund, 2012; Leminen, Westerlund, & Kortelainen, 2012).

Four archetypes of living labs

The conceptual framework distinguishes four archetypes of living labs based on the innovation process and the usage of tools: linearizers, iterators, mass customizers, and tailors. Linearizers represent living labs with a predefined linear innovation process and a standardized set of tools. Such living labs aim at improving the efficiency of innovation activities and reducing costs both in the innovation process and in the usage of tools. Iterators, in turn, have a predefined set of tools but adapt themselves to the needs of customers through an adaptive and flexible innovation process. Mass customizers take the given predefined linear innovation process, but try to increase the flexibility by customizing the needed tools for innovation activities. Finally, tailors rely on both iterative, nonlinear innovation processes and customized tools. Tailors include living labs who have prior experience and knowledge for innovation activities but wish to keep the innovation activities flexible.

Three preliminary propositions

Given that there is a substantial need for research on specific innovation tools in living labs (cf. Almirall et al., 2012; Dell'Era & Landoni, 2014; Edwards-Schachter et al., 2012; Ståhlbröst, 2008), the study makes a contribution to the literature on living labs by identifying and explaining such tools. Similar to Oxford Dictionary (oxforddictionaries.com), we view a tool as "a device or implement used to carry out a particular function". Hence, the study proposes the following three propositions for the future living lab research and for managers and practitioners involved in living lab activities:

1. Standardized tools decrease the complexity of innovation activities, and decreasing complexity leads to predefined incremental innovation outcomes in living labs.

2. A predefined linear innovation process decreases the complexity of innovation activities, and decreasing complexity leads to predefined incremental innovation outcomes.

3. Adopting an iterative, non-linear innovation process and customized tools for innovation activities increases the likelihood of an undefined and a novel innovation outcome.

Managerial implications

The findings imply that not only scholars of innovation but also business managers and other stakeholders contemplating innovation development through living labs need to consider open innovation mechanisms and their underlying assumptions. In particular, understanding tools – especially the differences between dif-

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ferent types of tools used to support innovation – helps stakeholders to decide what they want to achieve, and then to design or join living labs of a particular type to achieve those objectives. Hence, innovation tools aid managers of companies and organizations (public or private) to apply relevant innovation approaches as a part of their innovation management portfolio, particularly when innovation takes place through living labs. For this purpose, the study suggested preliminary implications as managerial implications, helping anyone interested in designing or participating in a living lab to better benefit from innovation tools. Finally, the study called for more research on innovation tools in living labs and other forms of open innovation.

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Taking Real-Life Seriously: An Approach to Decomposing Context Beyond "Environment" in Living Labs

Lynn Coorevits and An Jacobs

> *"Sometimes your greatest strength can emerge as a weakness if the context changes."*
>
> Harsha Bhogle
> Cricket commentator and journalist

The maturity of living labs has grown over the years and researchers have developed a uniform definition by emphasizing the multi-method and real-life, contextual approach. The latter predominantly focuses on the in situ use of a product during field trials where users are observed in their everyday life. Researchers thus recognize the importance of context in living labs, but do not provide adequate insights into how context can be taken into consideration. Therefore, the contribution of this article is twofold. By means of a case study, we show how field trials can be evaluated in a more structural way to cover all dimensions of context and how this same framework can be used to evaluate context in the front end of design. This framework implies that living lab researchers are no longer dependent on the technological readiness level of a product to evaluate all dimensions of context. By using the proposed framework, living lab researchers can improve the overall effectiveness of methods used to gather and analyze data in a living lab project.

Introduction

Innovation can be described as a five-step process that begins by identifying an opportunity, and culminating with the post-launch of a specific product or service (De Marez, 2006): i) opportunity identification; ii) concept design, development, and evaluation; iii) product design, development, and evaluation; iv) launch; and v) post-launch. However, the implied linear structure of this idealized process fails to convey the reality that user involvement may require multiple iterations or adjustments to a specific design than what is initially anticipated. This is especially true because it is difficult to accurately predict the future needs of users (Von Hippel, 1986). Indeed, innovation is an iterative process of need discovery – a pattern arising out of chaos – that is primarily visible in the front-end of design (Sanders & Stappers, 2012). This path from uncertainty to clarity was illustrated by Damien Newman's "squiggle" (Figure 1) in the context of design, but its message holds equally well for the process of innovation.

Sanders and Stappers (2012) built upon "the squiggle" and concluded that focus in the design process will be accomplished by trial and error in discovering and fulfilling (future) user needs. Living lab projects accomplish this iterative process by involving users throughout the entire innovation cycle (Dell'Era & Landoni, 2014). Indeed, living labs are renowned for being multi-faceted phenomena embodying both open and user innovation (Coorevits et al., 2016). Their multi-method approach enables developers to take a much more granular approach to product development from inception to conclusion.

One key component found within the living labs methodology, namely the "in the wild" experimentation, provides detailed insights into a broad area of contextual elements that can influence user experience (Ballon & Schuurman, 2015; Følstad, 2008; Kjeldskov & Skov, 2014; Veeckman et al., 2013). Here, we refer to "the wild" as a synonym for the context of use and, more specifically, the uncontrollable aspects of real-life environments. Most living lab projects focus on the environ-

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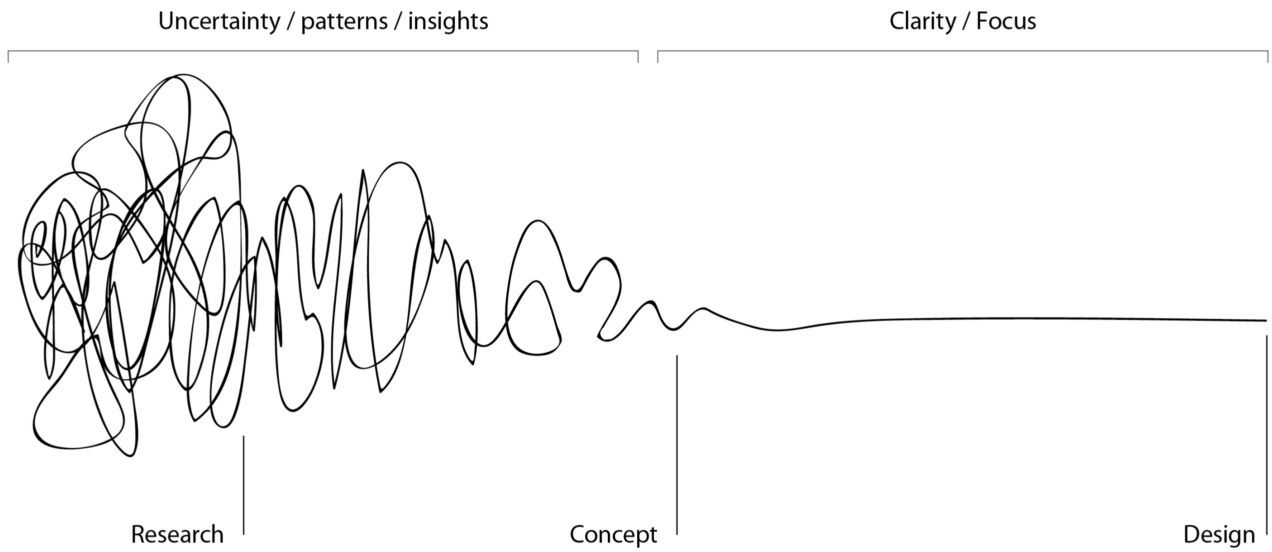

Figure 1. Damien Newman's "squiggle" representing the design process (CC-BYND: cargocollective.com/central/The-Design-Squiggle)

mental aspect of use context such as the evaluation of a product in a familiar or real-life environment (Følstad, 2008). These familiar environments – such as a usability lab that looks like living room – raise some interesting questions, for example, regarding the degree of realism required to make an evaluation meaningful and ecologically valid or how these complex contextual requirements affecting user experience can be researched in the fuzzy front-end of design (Dell'Era & Landoni, 2014; Mulder & Stappers, 2009; Stewart & Williams, 2005). However, context research is about more than the environment and entails researching all the factors that influence the user experience of a product (Visser et al., 2005). Conducting this in the earlier phases of the innovation process can support the planning and decision-making process of a specific living lab project. Context research can, for example, provide insights into how to identify and select realistic contexts for the tasks at hand, but also how to recruit realistic participants for the selected contexts. This in turn will lead to higher ecological validity (Roto et al.,2011), which is one of the primary objectives of the living lab methodology.

According to Følstad's (2008) literature review, half of all living labs are missing out on this opportunity because they do not research the use context before the testing phase takes place. The other half take a more ethnographic approach, which incorporates methods that appear oriented towards context research (Følstad, 2008). Contextual inquiry in the front-end of design includes methods that involve lead users (Von Hippel, 1986), generative design techniques (Sanders & Stappers, 2012), context mapping (Visser et al., 2005), and experience prototyping (Buchenau & Suri, 2000).

In other words, there are ample methods available that can measure or elicit context during the multiple phases of the innovation process, but they all define and describe it loosely. Mulders and Stappers (2009) and Dell'Era and Landoni (2014), for instance, emphasize the importance of contextualization via the previously mentioned methods, but they do not provide insights on the operationalization of context and more specifically how it can be measured during all the phases of a living lab project. Also, several researchers have emphasized the need for more guidance in the practicalities of researching context (Kaikkonen et al., 2005; Kjeldskov et al., 2004).

In this article, we will therefore first clarify the concept of context via a framework. Subsequently, we will describe the methodology of the project that we use as a case study to explore and explain the context dimensions and their properties selected from the literature. Next, we illustrate the context dimensions and properties with the case study project material and conclude with a reflection of its use for living lab research projects.

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Context: A Multi-Layered Concept that Is More than Just the "Environment"

As previously mentioned, due to its inherent complexity, the concept of context should receive more attention. In previous work, published by Geerts and colleagues (2010), we pointed out three concerns with the concept of context: i) it is habitually treated as a container concept, with a vague definition encapsulating different aspects that influence use; ii) it is often conceptualized as something static, underestimating its dynamic nature and change during the use process; and iii) it is recurrently used post-hoc as an explanation for results while operationalization upfront is neglected. Therefore, we will focus on its dimensions and complexities, allowing living lab researchers to make more conscious research design decisions when studying context.

Several dimensions of context can be found in the field of human–computer interaction, which is relevant given that our living lab research mainly focuses on the digitization of products and services. Human–computer interaction is a field that has grown out of the traditions of information science, psychology, sociology, etc. and therefore brings a synthesis of insights to inspire living lab research with a focus on the interaction of people with digital products and services in the wild.

Dourish (2004) distinguishes two perspectives on context: *representational* and *interactional*. In the representational view, context is perceived as a set of environmental features surrounding generic activities. Dourish states that context in this view is a form of information, which is delineable and stable, and where it is possible to separate the context from the activity. In the interactional view, context arises from (inter)action, thus from the relationship between the user's internal characteristics (e.g., motivation, intention, internalized societal values, goals) and the external characteristics (e.g., location, social aspects, technical components). Consequently, context cannot be treated as static information, but is a relational property arising out of an activity. This perspective is closely in line with the living lab methodology because it represents an approach for sensing, prototyping, validating, and refining complex solutions with end users (i.e., internal characteristics) in multiple and evolving real-life contexts (i.e., external characteristics). However, the operationalization and description of a dynamic context via relevant dimensions is challenging, and methodologies to measure these dynamics are rare or still in their infancy (Mulder et al., 2008).

We assert that a viable framework for living lab projects can be found in the work of Jumisko-Pyykkö and Vainio (2012) on the use context of mobile human–computer interaction. They refer to the ISO standard 13407 (ISO, 1999), which separated the user and system from the other components, but perceive context as something stable. Although it is better to treat context as a dynamic constant, we will start from Jumisko-Pyykkö and Vainio's representational perspective as an analytical approach, separating the context components and observing it as external to the user and system. We will elicit the dimension of context via the iterative nature of living lab research. The limitations are comparable to making a time-lapse video with different pictures: the quality of the video depends on the number and quality of snapshots we can take. It is not possible to map every single factor of context, even in a simple real-world environment, but we can take snapshots from different perspectives, at various key moments, and bring them together in a more like a collage of snapshots that come nearer to telling the entire story (Hinton, 2014).

The different dimensions of use context following the work of Jumisko-Pyykkö and Vainio (2012) are: temporal, physical, technical/information, social, and task. Table 1 provides details and examples of all five dimensions, their definitions, and the properties. To emphasize the dynamic aspect of context we positioned the time dimension first in the list. The dimension "technical/informational context" overlaps with the physical context when dealing with the property of artefacts, but we agree with Jumisko-Pyykkö and Vainio (2012) that the additional category "technical/informational context" does not, in some cases, completely overlap with the physical context dimension, because not all digital solutions have a very tangible physical component. In non-technical innovation domains, this dimension representing the technical/information context can thus be redundant.

We suggest that using the framework with its different dimensions as a guideline for the planning phase of a living lab research project and iteratively applying it in the subsequent steps will provide more actionable, rich, and dynamic insights into the use context. In the following sections, we will illustrate this suggestion using a case study showing how to use these contextual dimensions.

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Table 1. Dimensions of context of use (following Jumisko-Pyykkö & Vainio, 2012)

Dimension	Definition	Properties	Examples
Temporal context	"The user interaction with the system in relation with time"	Duration	Length of interaction, length of event
			Anytime, weekend, peak
		Before during and after	Preparations, documenting, triggers
		Temporal tensions of actions	Hurry, wait, rapid reaction
		Synchronous/asynchronous interaction	Talking/texting
Physical context	"The apparent features of a situation or physically sensed circumstances in which the user/system interaction takes place"	Spatial location	Geographical location, distance
		Functional place	School, work
		Functional space	Space for relaxation
		Sensed environmental attributes	Light, weather, sound, haptic
		Movement/mobility	Motion of user or environment
		Artefacts	Physical object surrounding interaction
Technical/ information context	"Relation to other services and systems relevant to the user's system"	Other systems and services	Devices applications and networks
		Interoperability, informational artefacts and access	Between devices, services, platforms
		Mixed reality systems	
Social context	"Other persons present, their characteristics and roles, the interpersonal interactions and the culture surrounding the user systems interaction"	Other persons present	Virtual, private/public; characteristics and roles with influence on user
		Interpersonal interaction,	Turn taking, co-actions, collaboration, co-experience
		Culture	Values norms and attitudes (e.g., a culture of uncertainty avoidance)
Task context	"The tasks surrounding the user interaction with the system"	Multitasking	Multiple tasks priority depends on goals, primary vs secondary tasks
		Interruptions	Interaction interrupted (e.g., by a technical problem)
		Task domain	Goal oriented (effectiveness, efficiency) vs action/process itself (entertainment)

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Method and Case Study Description

Given the exploratory nature of this research, this article describes a single case study using participatory action research. Action research is particularly relevant when producing guidelines for best practice (Sein et al., 2011). 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 of the research was to understand how context could be studied within living lab research projects. Because testing a new framework should be done iteratively to come to a middle-range, theory-like approach – a theorizing approach aimed an integrating theory and empirical data – a case study is an appropriate research tool for exploring key variables and their relationships (Eisenhardt, 1989; Yin, 2009). The purpose of the project was to develop an application that can assist employees in developing and maintaining soft skills such as empowerment after receiving coaching. The living lab project's starting point is situated at the front-end of design and took place over the course of one year, starting in January 2014 and running until February 2015. The partners in this project were: i) an SME that provides coaching to companies and came up with the idea of the application, ii) a large organization that provided access to its physical facilities, iii) staff (e.g., human resources, information technology) and primary users (employees), iv) and iMinds (now imec: www.iminds.be), a research institute with extensive experience in managing living lab research projects.

The general research structure implemented by iMinds Living Labs (now imec.livinglabs) combines the innovation process flow created by De Marez (2006), described earlier, with the design squiggle explained by Daniel Newman (2006) in Figure 1. The flow is iterative in nature because user input should be implemented throughout the entire innovation process and allows for optimization and modifications of the specific product. We follow Sanders and Stappers (2012) in their reasoning that a project should entail different approaches to move the innovation forward: i) exploring or understanding; ii) generating or making; and iii) evaluating. We depict this research flow for our particular case in Figure 2 and describe each phase and numbered step in further detail below.

The project started from the initial idea that employees need more support (via an application) to develop and maintain soft skills on the job. Then, the research flow described in Figure 2 was followed. In Phase 1 (from Idea to Concept) in order to better understand the innovation, insights were gathered from a range of modern technologies supporting behavioural change within organizations. Additionally, existing literature on behavioural change, technology adoption, and gamification (in organizations) was reviewed (Step 1). Based on these factors, a low-fidelity prototype was developed in the form of a paper mock-up (Step 2). In a following step (Step 3), a matrix was developed to invite different employees to participate in interviews. Coaches, the individuals being coached, and human resources personnel of large organizations were invited to provide input on the use context and the low-fidelity prototype developed in Step 2. Nine interviews (with a duration of two hours per interview) took place with different stake-

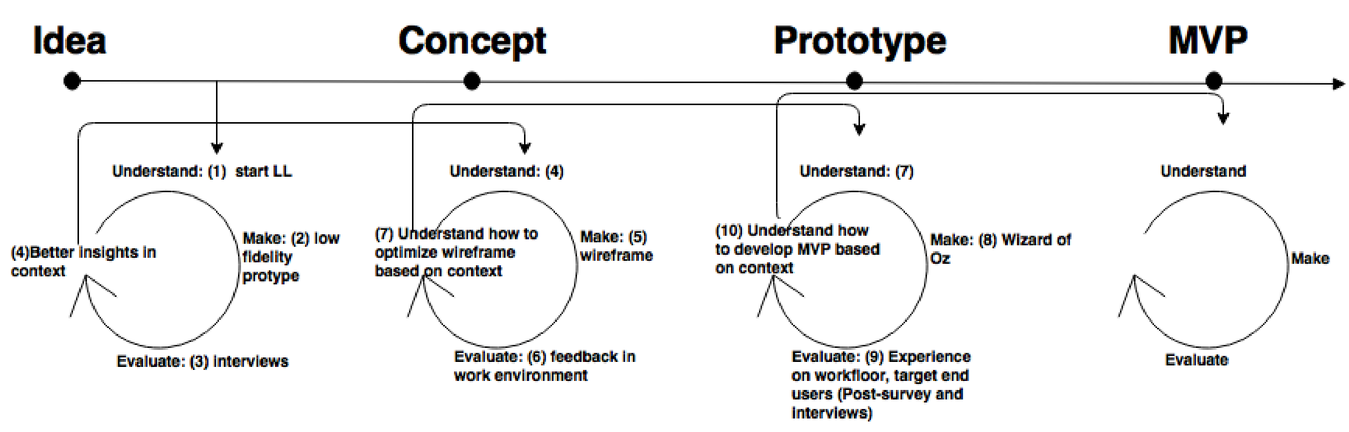

Figure 2. The research flow of the living lab case from idea to concept to prototype to minimum viable product (MVP)

holders to gain insights in the current way of coaching and behavioural change in the organization. The interviews were conducted in a meeting room of the organization and reflected on the use of the application in that organization, so the contextual dimensions were implicitly and explicitly included. A first introduction to the mock-up happened towards the end of the interview (Steps 3 & 4). In Phase 2 (from Concept to Prototype), the designer made wireframes in the form of a clickable mock-up for the application based on the first insights from Phase 1 (Step 5). These wireframes were evaluated and further co-designed with six potential end users of the application: three coaches and three individuals being coached. This co-design activity took place through one-on-one sessions of approximately 1 hour per potential end user in a meeting room of the organization (Steps 6 & 7). Based on the input of these potential end users, the wireframes were further optimized in Phase 3 (from Prototype to MVP) by the designer (Steps 7 & 8) and used as input for the implementation phase. or "Wizard of Oz assessment" – a technique that is used to evaluate an unimplemented technology by using an unseen human (i.e., the researcher plays the role of a hidden "wizard") to simulate the responses of a proposed system (Step 8). For this third phase, the appropriate technology to replicate the application was selected, namely Qualtrics (a survey application) and Panelkit (an e-mail management application). An invitation was sent to people that recently received a coaching session (n=20) asking them to attend a kick-off event of the testing phase. During the kick-off event, the goal of the test was explained and the process was described. Twelve people attended the kick-off event and initiated the testing phase. Finally, before creating an MVP, we invited people during and after the testing period to share their opinion on the testing phase via different qualitative research methods (i.e., a feedback form, online post-surveys with mainly open-ended questions and interviews) (Step 9) and to ensure the participative design process (Step 10).

During the living lab project, the participants were observed, conversations were recorded, and notes were taken by the researchers. The results were a priori coded using Table 1.

Results: Applying the Contextual Dimensions and their Properties to a Living Lab Case

Analyzing context via the framework provided us with a strong indication of how the technology would be used in the professional lives of the users and what the required features should be to enhance product–user interaction in that context. Without focusing on the different elements of context, certain critical features would not have been exposed, potentially resulting in failure of the technology (e.g., the requested name change from "coach" to "buddy" in the application) Because the application was not developed at the time of the test phase, the company was able to integrate any feedback iteratively and change the concept accordingly.

Table 2 shows the insights the researchers gathered while focusing on context during the different phases of the research flow. In each phase, we illustrate our insights per context-of-use dimension (temporal, physical, technical/information, social, and task) and its accompanying properties (e.g., duration, temporal tensions) as defined in Table 1. Only the properties for which we gained relevant insights for product development are discussed in Table 2. This means some properties might not be included compared to Table 1. This confirms the time-lapse video metaphor, which emphasizes the importance of gathering different perspectives, but also the difficulty of creating a full perspective on context.

Because of the multi-method and iterative approach in living lab projects, temporal context is intuitively integrated in the research process because the user–system interaction is studied over time. However, Table 2 shows that the temporal context dimension should be made more explicit to detect nuance and added value for the iterative approach. For example, in Phase 1, the employees perceived the suggested time of two weeks in between evaluations as too long. In Phase 3, the weekly time intervals provided for evaluation were perceived as too short. The participants were able to make a more accurate estimation because remaining contextual dimensions enriched the simulation of the future experience, and thus the perception of the ideal duration. By focusing on time more explicitly, researchers can much more easily identify components that otherwise would be overlooked, and they can focus on multiple components that appear simultaneously.

The physical context dimension guided our research design to operationalize context (Table 2). We purposefully held all research activities in the functional place for which the application was designed: an office. Throughout the different design phases, taking into account the user's concerns and feedback on the appropriateness of the application for their functional space is an iterative process, through which we seek the perfect balance between being work-appropriate and entertaining, fun, and engaging. The artefact component

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Table 2. Properties of each context-of-use dimension across the phases of the living lab project

Dimension	Phase 1: Idea to Concept	Phase 2: Concept to Prototype	Phase 3: Prototype to MVP
Temporal Context	**Duration:** Time between evaluation less than 2 weeks preferably weekly	**Duration:** Evaluations should be as soon as possible/immediate after a training moment	**Duration:** One week time between evaluations too short
	Temporal tensions of actions: Easy re-entry point: what if I drop out?	**Temporal tensions of actions:** What if meeting is unexpectedly cancelled, can I reschedule my training moment	**Before, during, after:** Insights in availability of buddy during meetings is necessary to know before choosing who will be buddy
	Before, during, after: Useful having something to remind you from time to time to work on habit change		**Syn-/asynchronous interactions**: Unable to start app, when requested buddy delays to reply
	Before, during, after/duration: When having a free moment (e.g. on your way home) an extra trigger is needed: "time for reflection"		**Before, during, after:** More triggers needed, reminder is not enough to stimulate behavioural change
			Before, during, after: When drop in motivation to change behaviour over time, system needs to spark motivation
Physical Context	**Functional places:** Interview in the workplace	**Functional places:** Session in the workplace, in meeting room	**Functional places:** Test, Interview and survey in the workplace
	Functional space: It's use is in a professional environment and thus game elements are not appropriate	**Functional space:** The initial wireframes are still too playful, more professional look and feel necessary for their big corporate environment	**Functional space:** The proposed prototype took the professional space too much into account
	Spatial location: Physical proximity of coach is necessary		**Movement/mobility:** If you are offside you can't access your professional mail address, which reminds you of the training moments
Technical/ Information Context	**Interoperability, informational artefacts and access:** The organization blocks access to certain websites, applications, … e.g. personal e-mail	**Other systems and services:** There are certain places in the buildings where you cannot access the wifi or 3/4G?	**Interoperability, informational artefacts and access:** The security infrastructure of the organization blocks any non integrated application
			Other systems and services: If I am on the move (going from one meeting to the next) I do not always have access to my emails and cannot receive/provide feedback

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Table 2. Properties of each context-of-use dimension across the phases of the living lab project *(continued)*

Dimension	Phase 1: Idea to Concept	Phase 2: Concept to Prototype	Phase 3: Prototype to MVP
Social Context	**Interpersonal interaction:** face to face interaction is preferred	**Culture:** The word "coach" refers to the company's hierarchy and associated with evaluation	**Culture:** Buddy is "too sweet", because giving personal feedback is not part of corporate culture
	Other persons present: Chosen coach needs to be already present in your activities (e.g. meetings)	**Interpersonal interaction:** It is important to choose your own coach (buddy) as someone you trust that can provide feedback in a safe environment	**Other persons present:** The habit you want to change is not always observable by the coach.
	Culture: Being asked to become someone's coach is perceived as an honour		**Other persons present/interpersonal interaction:** The coach needs to perform two roles: witnessing the behaviour and motivating. One or more persons can take on these roles.
	Culture: Autonomy is highly valued for example choosing your own training moments, coach, ...		**Other persons present/interpersonal interaction:** People experience difficulties to define their habits correctly. They need other their buddy to guide them in the process such as choosing an observable habit, defining the right steps to get there,...
Task Context	**Multitasking:** High level of multitasking, work priorities make difficult to focus on soft skills	**Interruptions/multitasking:** The timing of reminders should not interrupt an ongoing task flow (ok after meeting, but not when at work at desk)	**Interruptions/multitasking:** It is difficult to combine being active in a meeting and observing one's behaviour, when not being experienced in observation techniques.
	Multitasking: Link to own calendar is needed to integrate behaviour change in between or during appropriate work tasks		**Task domain:** Not every type of meeting is appropriate, ability to choose a good meeting to make first attempt of small step improvement of one's behaviour

of the physical context is not used in this analysis given that the project is oriented towards a mobile service, which consists of virtual and physical aspects. They are discussed further in the technical/ information context dimensions. There is still room for improvement in defining the components of the more technical/information context.

With the social context components, one can see the three layers of the Mantovani (1996) model: culture for the social-cultural (i.e., the other individuals present as a proxy for the situational level) and interpersonal interaction for aspects that entail more micro-interactions. We observed that *culture* is easier to extrapolate from interviews than reflections based on experiences in daily life, which are necessary to prompt aspects of *interpersonal interactions* on a more granular level. Therefore, both approaches are needed in order to elicit the multiple aspects of social context.

As is the case with temporal context, particular attention must be given to the subject of task context, which is a critical component of user experience research. In each step of the living lab project, there is a focus on the tasks and actions that users will fulfill to reach the goal of the application, in this case, behavioural change. In the wireframe session, the researchers assumed a given flow of tasks being executed by the users, which made it less likely that new contextual task components would be discovered. The session focused more on validating previous task context components. The danger when focusing too hard on this task component is that other components of context are easily neglected.

When a researcher or practitioner is confronted with contradictory findings using this framework in different living lab research steps, they must assess the results critically by looking at the methods of data collection, respondent validation, and analysis. Triangulation of results produced by multiple researchers can provide new insights and strengthen the quality of those findings. This triangulation highlights new perspectives that are supplementary and it enables researchers to dispute contradictory insights gathered from other researchers. The purpose of triangulating the data is to increase the understanding of a complex phenomenon, not to determine consensus nor to validate any specific results. Additionally, it is important to take a timelapse-based approach because it helps identify incompatibilities that will allow a more fundamental grasp of the data. The analysis can include looking for both consistencies and inconsistencies and, eventually, identifying patterns. Both researchers and practitioners must be prepared to question findings and interpretations and assess both the internal and external validity of the data. As with all context research, it is especially critical to be aware of potential biases and other factors that may influence the insights in the case (Malterud, 2001).

Conclusion and Managerial Implications

In this article, we defined and decomposed the container concept of context into various dimensions and properties. This structural approach allowed us to research the everyday life context of a living lab project. Although we implemented the framework retroactively, we were able to determine that it is feasible to detect the different dimensions and properties of context at any stage of the innovation process. The dimensions can be used, for example, as sensitizing concepts (Bowen, 2008). Our research further indicates that contextual input varies depending on the research method being used. This finding not only emphasizes the importance of a multi-method approach in living lab projects, it also highlights the necessity of focusing on use context during every step of the design process. In Phase 2, we only focused on a single dimension of context: the task context. However, participants still provided relevant input on the other dimensions as well. A first aspect was their vision on gamification, which evolved over time. We were only able to capture this aspect because the participants voluntarily mentioned it; it would not have been detected otherwise. This finding indicates that the framework can help researchers and practitioners to capture other contextual aspects that might influence the user experience if they are focusing too much on one dimension. It also shows that researchers should constantly keep open minds so that they are better able to detect new or additional dimensions. Additionally, it indicates that a single research step is never enough because context is dynamic and evolves over time. Timelapsing and multiple methods such as different prototypes, contextual observation, user testing, and participatory design can all bring important perspectives to complete the picture and should be considered to improve the outcomes of living lab projects.

The framework contributed to the analysis phase of the living lab project, independent of the maturity of the innovation. However, this approach to structuring context is also helpful in the design and execution of the research flow where different cycles of "understand – make – evaluate" will be executed. The model allows for a systematic and reflective process in the development of knowledge related to context. For example, spontaneous dimensions mentioned by interviewees (e.g., "I don't want a coach, I want a buddy") can indicate their priority, but making a list of different dimensions and their properties in the interview topic guide can guide the search for more contextual elements (e.g., other artefacts that can support behavioural change such a sticker on the user's computer that serves as a reminder to work on their soft skills).

The framework helps assist both researchers and practitioners to structure their approach, but it does not necessarily imply that all properties of those dimensions need to be found. The researcher can, for example, choose to solely focus on specific elements of context based on previous research indicating the importance of these elements. Additionally, dimensions of context, for example, temporal and place can be present in the same example, but that is a normal consequence of the multidimensionality of context. All components can influence each other. For example, the property "task interruptions" in a meeting is also influenced by the properties of the social dimension (other people present and their role in the meeting) and temporal dimension (availability of the buddy during meeting). The difficulties experienced when decomposing context make us more aware of the interrelationships between the different dimensions and their properties, which is an interesting analytical insight. The decomposition process of different dimensions into several properties was originally developed for mobile applications and as such might need improvement if applied in other digital and innovation domains.

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Our framework further contributes to bridging the gap in the literature regarding the lack of a clear methodological approach for living lab projects because it provides a more unified approach of measuring context. The structure can increase the impact of living lab projects, for example, by gathering more actionable user insights, and it can serve as a starting point to further refine this methodology. Furthermore, the implementation of the framework will either enhance the ecological validity of a living lab project or the extent of its practical validity within the innovation process. In particular, because researchers do not have to rely only on observable phenomena or what is casually mentioned by participants, they will be able to search for all relevant dimensions of context that might influence the user experience.

If innovation managers only focus on a single aspect of user research, they can only expect a limited overview on the context of use. In order to gain a more thorough, 360-degree overview, they need to implement an iterative research path whereby the framework can help them focus on varying dimensions of context and sufficiently balance the cost and quality of the output.

In conclusion, this article provides a way to take context into consideration in living lab research by describing and applying a framework that helps to structure all the different dimensions and properties of context. The framework can reduce the experienced challenges to introduce "the wild" into living lab projects by focusing – in a more structured way – on the dynamic relationships of people and activities in real life.

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Heading for a FALL: A Framework for Agile Living Lab Projects

Tanguy Coenen and Sarie Robijt

> *Our greatest glory is not in never falling, but in rising every time we fall.*
>
> Confucius (551–479 BC)
> Teacher, editor, politician, and philosopher

Living lab methodologies need to enhance reactivity to changing requirements as these appear in a project. Agile methods allow for quick reactivity, but have been critiqued for not sufficiently taking into account the end-user perspective. In this article, we describe how to blend living lab methodologies with agile methods and, to this end, we present a Framework for Agile Living Lab projects (FALL). To make the framework actionable, we propose a number of actor roles. With concrete examples from living lab practice and a discussion of the theoretical basis, this article is relevant to both academics and practitioners.

Introduction

Agile development and living labs have separately received much attention from innovation-driven practitioners and academics over the last decade (Almirall et al., 2008; Dybå & Dingsøyr, 2008; Følstad, 2008). Despite different backgrounds and foci, both concepts share some commonalities. As major goals common to both approaches, we identify shared ambitions to: i) increase cost efficiency, ii) augment stakeholder collaboration, and iii) cooperate with users. However, both approaches are characterized by some weaknesses. Although living labs champion end-user involvement in both design and development, results from user co-creation often fail to become incorporated in ongoing technological development cycles (Sauer, 2013). Given that innovation frequently has unintended outcomes (Sveiby et al., 2009) – such as unforeseen shifts in requirements – living labs react more rapidly to such shifts in scope. Agile methodologies, on the other hand, have been developed specifically to tackle shifting requirements, yet they lack a structured focus on users and do not target collaboration with them (Cajander, 2013; Singh, 2008).

The question that we aim to answer here is:

How can we integrate agile methodologies, with their advantages for structuring flexible work processes, with living lab methodologies, which are known to be user-driven?

Addressing this question should yield novel insights into how to conduct living lab projects, both from a theoretical and practical perspective, by means of a framework, which we have named the Framework for Agile Living Labs (FALL).

The article is structured as follows. First, we introduce FALL and its component phases. Next, we describe FALL's various actor roles and their associated tasks. Then, we illustrate how SCRUM acts as a backbone for this agile framework. Finally, we highlight the contribution of the study and its limitations, and we offer conclusions.

FALL: Framework for Agile Living Lab projects

In this section, we present the essence of the FALL model, which is the result of an inductive (from practice to model) and deductive (from existing theory to model) process. The inductive part was done by participatory action research through hands-on experience in a variety of Flemish living lab projects run by imec.livinglabs (www.iminds.be/livinglabs/) and the "VRT Proeftuin" (deproeftuin.vrt.be). The theoretical foundations for the deductive part are rooted in design science research, a scientific discipline that aims to contribute to the scientific body of knowledge by building information systems. The main phases of FALL are derived from the

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action design research (ADR) method (Sein et al., 2011). However, in order to make a research-oriented framework more practical and applicable in daily living lab practice, we implemented FALL using agile techniques.

Figure 1 illustrates FALL, which focuses on living lab projects running from the early stages of a project idea to the real-world evaluation of a working software prototype. This framework was created because living labs need a robust methodology to structure and value user feedback. Because innovation frequently has unintended or unexpected effects (Sein et al., 2011), living labs must adjust rapidly to user feedback. This need for rapid adjustment is further underlined by variability in the timelines of project objectives and the diversity of control points, as commonly experienced in living labs (Leminen & Westerlund, 2011). Each of FALL's component phases is described in the subsections that follow.

Phase 1: Problem Formulation

The first FALL phase, Problem Formulation, aims to produce a concise statement to scope the effort of the team, which should reflect the perspectives of relevant end users and stakeholders. There are different ways of gathering information on what the problem statement should contain. The living lab and user research literature has much to say on how to leverage insights and domain knowledge from representative end users and stakeholders, for example through co-creation techniques and focus groups. Another way is to create online crowdsourced ideation campaigns on general topics that representative end users can participate in. Outputs of such efforts (e.g., story boards, user scenarios, Lego Serious Play models) in the problem formulation phase are by definition abstract, guiding the overall design and development efforts in the subsequent phases, where the outputs of co-creation become more concrete.

In addition to the co-creation of problem formulations, and as is customary in design science research, it is important to map the existing state of the art on the type of system being created. This step is often forgotten or not accounted for in living lab literature, yet creates an important baseline against which to gauge the innovation potential of the project.

From the problem definition, a first solution can be devised in the form of a set of assumptions to be tested by building minimum viable products (MVPs). However, these assumptions are often uncertain statements that should be verified. As in lean UX (Gothelf & Seiden 2013), selecting what assumption to test first can be done by prioritizing them in terms of high risk and low maturity. Risk refers to the consequences of the assumption being false while the project still holds the assumption to be true. Maturity is the amount of knowledge that the project team has regarding the assumption. Testing high-priority (i.e., high-risk and low-maturity) assumptions should be the focus of MVP 0 (see Example 1). The functionality of the MVP can be described using a SCRUM backlog that bundles and de-

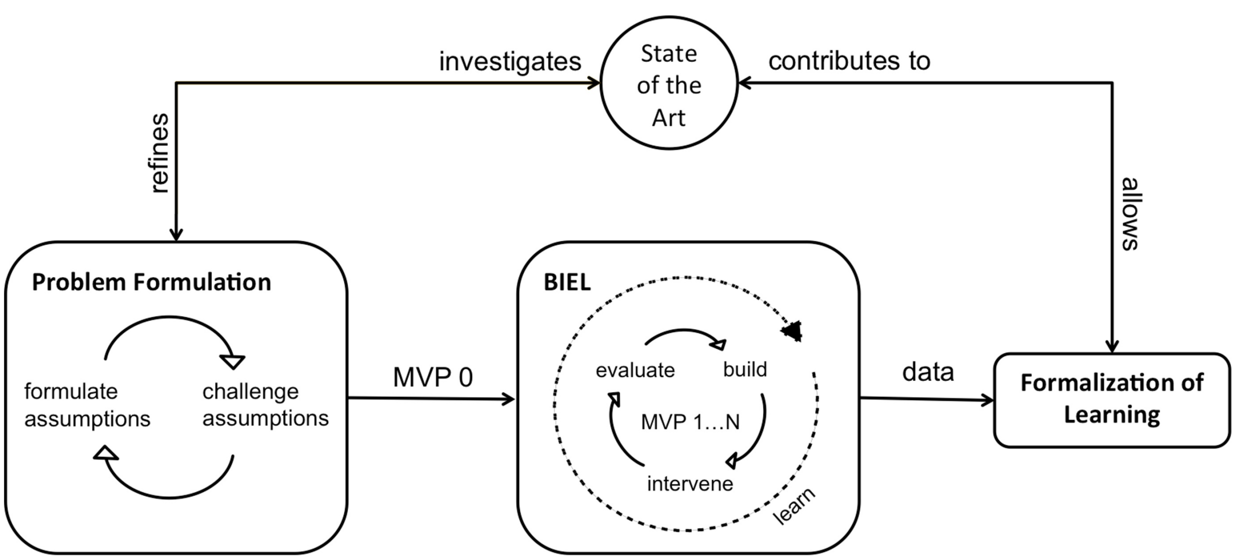

Figure 1. Framework for Agile Living Lab projects (FALL)

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Example 1. Testing high-priority assumptions with the first MVPs

In the ZWERM (www.zwermgent.be) project, we started from a very general problem statement: to engage smart citizens with the city through mobile applications. However, this problem statement was too broad to be actionable. By gathering feedback from different stakeholders in the project (including a great number of citizen inhabitants, which were the prospective end users of the project), we arrived at the following problem statement: "How can we build a system that allows neighbourhood citizens to play a game through which they increase social cohesion and use this social cohesion to take actions that are important to the neighbourhood?" A conceptual solution was imagined to answer this question, which could be expressed as a number of assumptions:

1. The question can be answered through Internet-of-Things-enabled public space furniture.

2. The question can be answered by building a game in which a "check-in" (a person swiping an RFID card on a card reader) will be the central game mechanism to engage players with the system and to get them to know each other.

3. The question can be answered by creating a number of missions that can be played with the user's own device and inciting the user to take positive action.

Of these three assumptions, the second and third one were identified as being the highest risk and least mature. Therefore, they became the object of the first MVPs.

scribes the functionality of the MVP as user stories. A user story has the form "as a <role> I can <functionality>". Once MVP 0 has been defined in a backlog, it needs to be built, evaluated and tested, which happens in the next phase.

Phase 2: BIEL (Build - Intervene - Evaluate - Learn)

The creation of the successive MVP prototypes takes place in the "build - intervene - evaluate - learn" (BIEL) phase, in which the MVPs are always created (built), presented for feedback (intervention), and evaluated. The BIEL phase is derived from Sein and colleagues' (2011) action design research method. The reason why these four activities are bundled into one phase is because they take place concurrently and not necessarily in sequence. Indeed, it is often the case in a living lab that an intervention in a real-world environment takes place over a longer period of time. In such a situation, building goes on while the intervention is taking place, as for example, bug fixes and change requests are addressed and integrated in the live functional prototype. Similarly, evaluation can take place during the intervention, for instance using qualitative observations.

Learning has been added as a separate loop in Figure 1 to indicate that it is highly ingrained in all activities taking place in the BIEL phase. Indeed, living lab practitioners, like other people, do not learn as a separate activity, but learn by performing all the necessary activities in the BIEL phase. For example, the actual building of MVPs yields extensive learning on what will work and what will not.

Such MVPs, in the context of FALL, would better be termed minimum viable *prototypes*. Indeed, all MVPs submitted for feedback are intermediate prototypes on the road to the outcome of a living lab project. Examples of prototypes often used in living labs include:

- paper prototypes (Snyder, 2003), which are sketchy representations of the graphical user interface (GUI)

- graphical user interface (GUI) mock-ups or extended paper prototypes with graphic style added (see Example 2)

- clickable prototypes that allow for a certain degree of interaction

- functional prototypes that can be used on the device of the user allowing real-world intervention and testing

In living labs, all participating stakeholders – including end users – can build or participate in the creation of prototypes. As such, we perceive co-design as a possible process of the BIEL phase. A technique we often use for such co-design is the lean UX "design studio" technique, in which end users are asked to individually draw the GUI for a system, after which a GUI design is made to reflect the group consensus.

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Example 2. GUI mockups as MVPs

After identifying the most important assumptions and deciding to make them the subject of MVP 0, the partners of the ZWERM project started working on several MVPs. MVP 0 consisted of GUI mockups for the website used to play the game. Feedback was gathered from representative end users, and a new version of the GUI design was created (MVP 1). Next, a functional version of the website and the check-in system were built and deployed at our research facility during a three-week period (MVP 2). Data was gathered through observations, a survey, and an analysis of the system logs. This allowed us to formulate answers to assumptions 2 and 3 (see Example 1). The feedback on assumption 2 was definitely positive, while the feedback on assumption 3 was more nuanced, with some missions working well and other not working at all. Based on what we learned during the intervention with MVP 2, we created a fully functional prototype (MVP 3) that was tested in real-life environments over a four-week period. Again, data was gathered through observations, a survey, and an analysis of the system logs.

Phase 3: Formalization of Learning

The Formalization of Learning phase is where all that has been learned is reflected upon and placed in some format that is fit for consumption by an academic, a business, or a public audience (see Example 3). In the case of the former, it is important to contextualize the formalization of learning in terms of the existing scientific knowledge base (i.e., the state of the art) and the problem formulation. For a business audience, the formalization of learning may be more oriented towards insights that are useful for market introduction of the concepts, underlying the system.

FALL Roles

In order to use FALL, a number of roles are necessary, because certain tasks must be performed during a FALL project. Assigning these tasks to roles in the living lab team can ensure that all tasks are accounted for. Starting from the main actions to be completed in our experience of running living labs (inductive) and from the literature (deductive), we identify eight key roles, which are borrowed from the literature on living labs, user research, agile methods, and user experience design:

Example 3. Formalizing learnings from the MVPs

After the real-life environment intervention with MVP 3 and the evaluation based on the collected data, we drafted a number of papers, which described the system and formulated guidelines for the future design of similar systems. In addition, the core findings of the entire project were formalized into a project description (vision, architecture, business plan) for a spin off that leveraged the main elements of ZWERM.

1. *Process manager:* as in agile methods, the aim of FALL is to increase the amount of self-organization of the team. However, someone is needed to guide the team with the methodology or process of working with FALL. This is the responsibility of the process manager.

2. *User researcher:* takes the lead in getting input from users at different stages of the project. In addition, the user researcher has the responsibility of keeping the story backlog up to date from the perspective of the end users. They are also responsible for making sure the problem formulation is grounded in the state of the art from a non-technical perspective.

3. *Researcher:* active in an academic domain that is relevant to the design problem in the social or natural sciences, researchers contribute the insights that are needed to create innovations by leveraging knowledge from various research fields and applying them to the design problem at hand.

4. *Architect:* their role is to create the systems architecture and to update and prioritize the backlog in terms of the stories that are not facing towards the user, such as “the server backend should be able to automatically backup the user data that is stored in the database”. The architect is also responsible for making sure the problem formulation is grounded in the state of the art from a technical perspective.

5. *UX Designer:* responsible for creating MVPs that represent the GUI of the system. These can be wireframes, clickable prototypes, or GUI mock-ups. It is crucial to note that, although the UX designer holds the skillset to build these artifacts, creating them should never be done solely from only the perspective of the UX designer. Core to the philosophy of

FALL is that the UX designer should work with the feedback that was gathered from the project actors (other team members, representative end users, etc.).

6. *Developer:* responsible for translating the story backlog into functional MVPs.

7. *User:* involved in the project to bring domain-oriented knowledge to the team through co-design and usability testing processes, as guided by the user researcher. It is important that the users involved in the FALL project be as representative as possible of the user group that will eventually use the outcome of the living lab project.

8. *Stakeholder:* like users, stakeholders are also involved in contributing domain-oriented knowledge, but are not necessarily representative of the eventual user population. Stakeholders often hold higher-level interest than users and operate from a policy, commercial, or academic point of view.

SCRUM as a Backbone

The Problem Formulation, BIEL, and Formalization of Learning phases require work to be done by a multitude of people. Within FALL, we propose to facilitate this work through SCRUM, the most widely adopted agile methodology. As a result, work in the living lab will be organized according to sprints, which are time-boxed iterations. At the beginning of each sprint, the objectives and the end-time of that particular sprint are defined. These objectives differ according to the phase of FALL in which the project is situated. In the Problem Formulation phase, the objectives will be focused on scrutinizing the body of knowledge and creating a problem formulation with related assumptions on how to address the defined problem. In the BIEL phase, the objectives will be on creating MVPs, testing them and defining new MVPs based on insights from building and testing previous versions. In the Formalization of Learning phase, the aim will be to contribute to the body of knowledge based on what was learned during the living lab's execution.

At the end of the sprint, a demonstration of the work is given and the whole process is evaluated in a sprint retrospective. Also, the backlog is updated according to the tasks that present themselves in the future milestones of the FALL project. The story backlog therefore constitutes a crucial FALL project management tool, as it keeps an overview of tasks in progress or to be completed. Such a backlog can be established at the start of each new BEIL cycle in which a new MVP is to be developed.

Generating the user stories in the backlog can be done by the project group (including users), for example by allowing group members to generate user stories on sticky notes. Subsequently, user stories can be prioritized using the categories of the MOSCOW method: "must have, should have, could have, won't have" (Figure 2). Most of the time, the former two categories will form the basis for BIEL activity in the upcoming cycle, yet user stories in the latter two should be kept for future use.

Conducting FALL as a SCRUM project provides the agility that is needed in living labs, where requirements are unstable due to ongoing end-user feedback. Having time-boxed iterations, at the start of which the premises of the project are questioned, helps in integrating new insights.

Figure 2. User stories being prioritized using the MOSCOW method
(Photograph courtesy of the D-Pac project: d-pac.be)

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Conclusion

With agile methods, it is challenging to take the user perspective into account in a structural manner, whereas living labs often fail to incorporate emergent user feedback into running design and development processes. We proposed to address these issues by creating a framework that allows living labs to be executed in an agile way. FALL – the Framework for Agile Living Labs – draws on lean UX and SCRUM as agile methods. In addition, it takes design science research as a theoretical basis and structures the process along the lines of action design research. Through this article’s concrete examples, practical guidelines, and theoretical foundations, we have attempted to address both theoretical and practical implications. FALL can be used as a basis on which to align the research, design, development and evaluation activities that are core to many living lab projects, providing actionable guidelines to researchers and practitioners alike.

This article has made the following contributions. First, we introduced agile methodologies into the theory and practice of living labs. Second, we proposed an actionable, yet theoretically grounded set of constructs (MVP, BIEL, etc.) around which to conduct a living lab project in an agile way. We have placed this into a framework (FALL) and indicated how this framework can be supported methodologically through the different phases of FALL. Third, we proposed principles to be taken into account when performing living lab projects according to FALL: define project roles and use SCRUM as a backbone for project planning. As such, we contributed prescriptive knowledge to living lab theory and made a sep towards overcoming practical hurdles that living lab projects can be confronted with.

A main topic in living lab research is how to gather insights from end users and stakeholders through participative techniques. Although we have hinted on ways to achieve this, we did not cover the participative processes in detail, given our focus on providing a general overview of the processes in FALL. As a key avenue for further research, greater elaboration is needed regarding the participative processes that are appropriate in different phases of FALL and the properties of their outputs.

About the Authors

Tanguy Coenen is head of the software application prototyping team at imec and has a PhD in Business Administration from the Solvay Management School of the Vrije Universiteit Brussel in Belgium. During his career, he has been involved in many living lab projects, both at the national and the European levels. Tanguy fosters a variety of research interests but is focused on a “City of Things” project, which is applying living lab concepts to achieve the vision of a city as a living lab innovation platform.

Sarie Robijt currently works as a Service Design professional in retail business. As a service designer, she takes up several roles from user experience analyst to workshop facilitator and innovation coach. During her time at VRT Proeftuin, she worked on setting up and maintaining a living lab in the media innovation industry.

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Keywords: living labs, design science research, agile, methodology, SCRUM, lean UX

The Design-Driven Living Lab: A New Approach to Exploring Solutions to Complex Societal Challenges

Rens Brankaert and Elke den Ouden

> *If you ask customers what they want, they will tell you: 'Better, faster, and cheaper'– that is, better sameness, not revolutionary change.*
>
> Guy Kawasaki
> Marketing specialist, author, and venture capitalist

In this study, we aimed to explore the potential of a design-driven living lab as an innovative approach to addressing societal challenges. This living lab incorporates design qualities such as exploration, open-ended results, and disruption. This approach was applied in three case studies within the context of dementia, each of which explored the impact of Qwiek.up – a media system that creates an ambient experience in a room through projection and sound. A cluster analysis of the results in the three case studies showed that the system has considerable potential for people with dementia, and possibly also for other groups. In addition, the design-driven approach led to new applications in care, improved functionality, and a broader design space. Our findings show that design-driven living labs can widen the scope of innovation and improve the value proposition of an innovative solution.

Introduction

With an ageing global population, there has been a substantial increase in the number of people living with dementia around the world (Wimo et al., 2003). Dementia severely hampers an affected individual's ability to live independently, and therefore they often have to rely on both formal and informal care (Prince et al., 2013). Thus, dementia is putting considerable pressure on healthcare costs and quality (Knapp et al., 2013). Furthermore, in Europe, healthcare budgets are being cut, including those for dementia care (Prince et al., 2013). The consequence is more accidents and a lower quality of life for people with dementia. However, the search for a solution is not straightforward, because dementia is an example of a "wicked problem" (Martin, 2009), meaning it requires a multi-perspective approach. The various stakeholders each have their own perspective and often contradictory needs (Brankaert et al., 2015).

Previous studies have revealed that living labs are suitable for tackling complex societal challenges (Liedtke et al., 2012). The living lab allows for different innovation methods, such as user evaluation, to be applied in collaboration with various stakeholders to find and evaluate new solutions (Brankaert, 2016). In a living lab, the validity of results is high because the methods are applied in a real-life context. Additionally, living labs involve various stakeholders, such as end users and both public and private parties. Indeed, living labs should involve end users in constructing meaningful innovation with and for them through co-creation (Almirall et al., 2012). Moreover, involving stakeholders with a market interest in living lab activities fosters successful innovation and increases market impact (Schuurman et al., 2016). Thus, this approach supports innovation in all phases of the lifecycle and enables a rapid route to market for innovative products (Leminen et al., 2012).

The Design-Driven Living Lab

Rens Brankaert and Elke den Ouden

Although studies on living labs focus on evaluating solutions (Veeckman et al., 2013), finding innovative solutions requires going beyond the evaluation of existing offerings. Another aim of living labs is to look at problems creatively, and this aim can be achieved by adopting a design perspective. Design helps by identifying needs, conceptualizing, prototyping, implementing, and taking different perspectives (Krogstie, 2012). In addition, designers can explore, envision, and create more disruptive scenarios (Hummels & Frens, 2011).

In the literature, it is suggested that living labs need outlines and structured, predefined goals (Korman et al., 2015). However, to deal with uncertainties in complex societal challenges, we need to take an open attitude to innovation in living labs. Moreover, different stakeholders can have different views and needs. There might be, for example, conflicting perspectives among business and care stakeholders concerning value versus revenue. To address such challenges, innovators need to apply integrative thinking and be able to hold two opposing ideas in their minds, thus creating a synthesis that contains elements of both while improving each. Designers have skills in this area, they seek factors that are not immediately obvious, and they tend to see a problem as a whole (Martin, 2007). Moreover, designers are able to generate creative resolutions in the form of new ideas.

With this article, we aim to present a new perspective on living labs by introducing the design-driven living lab and to investigate its potential by asking the following research question: *How can we implement a design-driven living lab to explore innovation for dementia care challenges?* We explored this question inductively by applying a design-driven living lab approach in three technology-based case studies.

Methodology

For this research, we conducted an explorative in-context study to investigate the effectiveness of a design-driven living lab approach. The living lab was positioned in a real-life environment, as opposed to a true lab environment, and we involved users as co-creators rather than subjects of study (Almirall et al., 2012). In addition, our design-driven focus allowed for open-ended insights into the context through an evaluation that was driven by the use of a "technology probe" (Gaver et al., 1999; Hutchinson et al., 2003), meaning that the participants were allowed to use the focal technology as they saw fit – without restrictions or prescriptions. Moreover, they were motivated to contribute to the value proposition: the promise of value to be delivered by a product. They were encouraged to experiment with the technology and to reflect on their needs and the overall context through the technology. As such, the design-driven living lab approach goes beyond the mere evaluation of technology.

Through this design-driven approach, open-ended results can be generated in collaboration with the relevant stakeholders (Sanders & Stappers, 2008). In our case study, people with dementia, care professionals, and a company were involved. In this way, a design-driven living lab can be used to navigate the "fuzzy" front-end of innovation, which is the initial phase of innovation where the context and target market segment are still unclear. The design-driven living lab involves design activities, such as identifying needs, conceptualizing, and taking different perspectives (Krogstie, 2012) within the living lab (Koskinen et al., 2011). We aim to use these activities in this study to address challenges in dementia care.

The three case studies in this article focused on the introduction of an innovative technical solution – the Qwiek.up system. By putting this device in the real-life contexts, we wished to gain an understanding of its contribution to dementia care, our understanding of dementia care itself, and potential new directions to take with the design. The results of the three case studies were compared and clustered to formulate insights into the design-driven living lab approach when applied in the context of dementia.

Technology probe: Qwiek.up

The technology probe used in the case studies is the Qwiek.up media system (Figure 1), which was developed by the company Qwiek (qwiek.eu). Research shows the importance of meaningful activities for good mental health and general wellbeing (Gold, 2013). The system addresses the problem of having insufficient suitable activities for people with dementia and therefore supports caregivers with their task. Through visual and audio output, this system creates a calming ambient experience for dementia patients in institutional care homes. The system comes with easy-to-use "experience modules", which simulate experiences such as a walk through the woods, looking up at a starry sky, visiting a farm, or viewing a custom slideshow of family photos with music. To use the system, the caregiver inserts an experience modules into the system, which then automatically initiates the corresponding experience. The system can transform a room into an experience by projecting images and video onto a wall or a ceiling (Figure 1). This device is a useful tool for professional caregivers in dementia

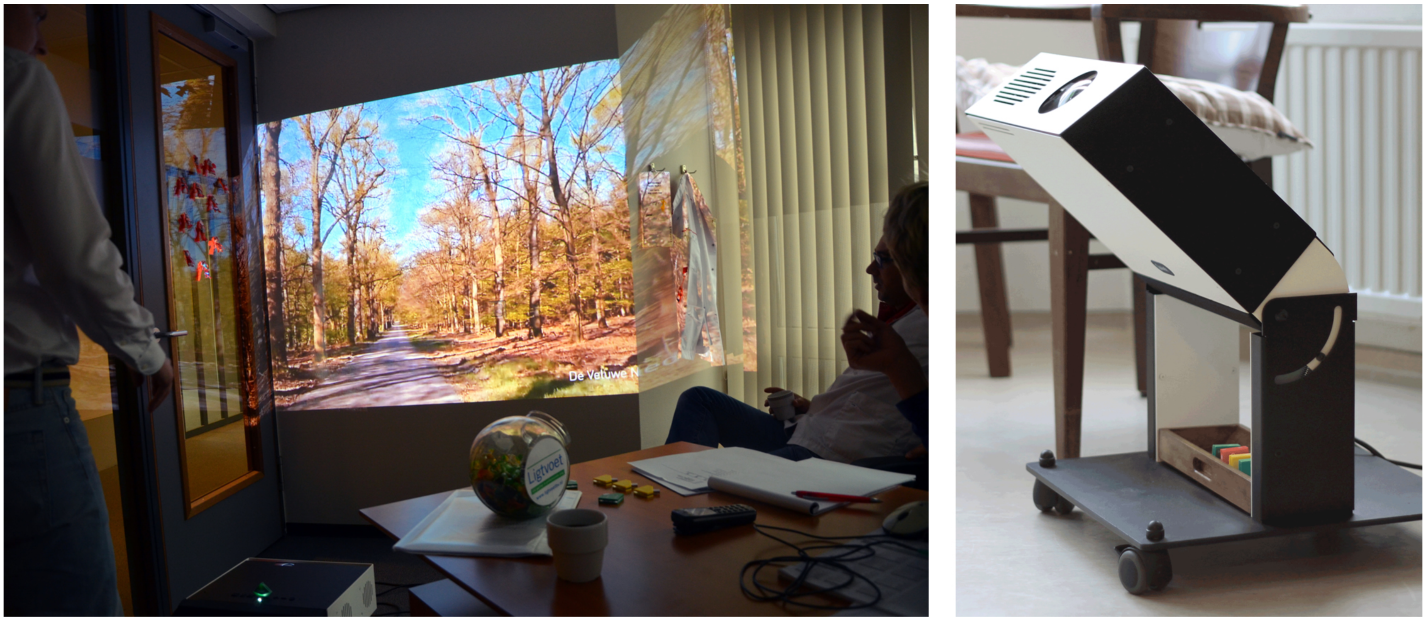

Figure 1. The Qwiek.up media system (right) depicting a walk through a forest on a regular wall (left)

care homes, where it can be used as a meaningful activity or as a non-pharmaceutical remedy for stress and agitation, which potentially reduces medicine use in care environments.

Several interventions that use immersive elements and sound have previously been investigated, such as for example "Snoezel(en) rooms" (tinyurl.com/go3v7as), which are controlled multisensory environments designed to create a soothing experience by stimulating the senses (Riley-Doucet & Dunn, 2013). These earlier interventions, however, did not use familiar content for patients or were limited to a single room (Jakob & Collier, 2015). The Qwiek.up system, in contrast, adds value because it is easy to use and is integrated into a wheeled stand that can easily be moved from room to room. Additionally, using a system that is beyond the prototyping phase allows the users to focus on how the technology functions within the context and the various applications it can include.

The main focus of the study was not to obtain feedback to further improve the system, but rather to explore how caregivers use the system in everyday practice. In this way, we aimed to explore the care context and reveal latent user needs. Additionally, this allowed us to gather new perspectives on the value proposition of the system. Nevertheless, insights relating to usability and the concept itself can be expected as a by-product. Therefore, our aim was consistent with our conceptual proposal of the design-driven living lab: to discover opportunities by introducing a new piece of technology in a real-life context.

In-context evaluation of the Qwiek.up system
Research on the Qwiek.up system was carried out in three care environments for people with dementia. Two studies were performed in a care home and the third one was performed within a dementia day programme where people with moderate dementia attended a facility for daily activities, yet still lived at home. The company behind the Qwiek.up system was involved in setting up this study and reflected with us on the outcomes. The characteristics of the three case studies are described in Table 1.

To carry out the study in the three locations, the following sequence of activities was adopted:

1. The system and research method were introduced to the staff.

2. Staff members were invited to use and experiment with the system during the study period. During this period, they recorded their experience with the system on an evaluation form.

3. After the study period, additional insights were collected during a focus group with the care professionals.

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The evaluation form used to capture the experience requested the following details: a description of the experience, the length of engagement, its usefulness in the care context, and usability. To aggregate the findings in each of the case studies, we performed a cluster analysis with the retrieved data from both the form and the focus group (Koskinen, 2003). In this regard, the study had a dual role. We asked staff members to use the system and describe their experience, and then we instructed them to go beyond evaluation and experiment with using the device. This second role inspired new design directions and widened the value proposition. During the focus group, we encouraged them to reflect on their experience. Subsequently, the findings were aggregated into three topics to identify the role of the design-driven living lab in the innovation process. The insights gathered concerning both the system and the living lab approach were then shared with the company that created the system and interpreted with them.

Results

The three case studies delivered improvements to the system and demonstrated its value in dementia care. These results, from both the evaluation form and the focus group, are shown in Table 2. Especially in case studies 1 and 3, the system was found to be a strong addition to formal care. The system was used as an activity for individuals and groups with dementia, and it increased the efficiency of care provision by giving the nurses more time to engage in their care practices. During the focus group with users from case study 3, they even mentioned that the system could reduce the need for medication in some cases. In case study 2, the system was less well received; however, here the professional caregivers showed less willingness to experiment with the system during their general care practices.

The cluster analysis of the data from both the evaluation forms and the focus group identified three clusters of topics: new insights concerning applications in care, the functionality of the system, and possible design extensions. The business perspective on each of these topics was added to these results. The results for each of these topics are described in the subsections that follow.

Topic 1: Applications in care
By using an open-ended evaluation, we found that, although the original target context (care homes) was suitable, a different context (day programmes) also shows great potential. The care professionals even indicated it that they felt it could be used for other conditions such as autism, because it provides a comfortable and recognizable ambience. In the case study 3 in particular, multiple purposes for the system were suggested. The system had benefits as a soothing individual activity as intended by the design. However, it was also used as an interactive group activity, as an activity for quieting down a group after lunch, and for one-on-one engagement and storytelling.

The attitude of the caregivers at the day programme centre might well have played an important role in this study. During the focus group, for example, we found that users in case study 3 were more engaged compared to those in the other case studies. They were very enthusiastic and they actively contributed more feedback than expected. They even wrote a thirty-page report in addition to the evaluation form to describe their experiences with the system in detail.

In summary, the users experimented with the device in all kinds of ways and discovered new purposes while doing so. This broadened the potential market for the system and also allowed us to discover latent needs in this care context. From a business perspective, the company reflected on the study that these insights added value to the system and opened potential future markets.

Topic 2: Functionality
We also discovered the need to make improvements to the Qwiek.up system in terms of functionality, technology, and usability. For instance, the projector sometimes malfunctioned, and the company should prioritize fixing such technical issues. Additionally, some of the care professionals in case study 1 found the system hard to use. They suggested making the system's physical controls easier to use or adding a remote control. Furthermore, in some of the experience modules, the music that was preselected by the company to fit with certain videos did not match, resulting in a conflicting experience.

The company is already improving some elements of the product based on this feedback on its functionality and is investigating the potential of adding a remote control or other ways of interacting with the system by both the care professionals and the patients.

Topic 3: Design extensions
Opportunities arose in all three case studies for improving the conceptual design of the Qwiek.up. In case study 1, for example, the potential of adding interactivity was discussed to allow those with dementia to have

Table 1. Context description of the three case studies

	Case Study 1	Case Study 2	Case Study 3
Country	Netherlands	Germany	Germany
Care context	Care home	Care home	Day programme
Dementia profile	Advanced	Advanced	Moderate
Care professionals	6	4	3
Residents	14	11	28
Study period	29 days	33 days	35 days
Evaluation records	6	7	15

Table 2. Evaluative results concerning the Qwiek.up system in the three case studies

	Case Study 1	Case Study 2	Case Study 3
General response to the system	Positive	Moderate to negative	Very positive
Experience modules	Natural modules were preferred (e.g., Aquarium and Forest)	Module of starry sky was used to help individuals to sleep better; others were less appreciated.	Residents responded well to the natural modules; in some cases, there was a mismatch between image and music in the modules.
Technical difficulties	The projector had some issues with finding focus	Physical controls on the system were considered difficult to use.	None
Experience	Various use cases were found such as group sessions (max. 30 minutes) and individual use.	Positive use for one-on- one session and sleep sessions; other uses were not explored.	Many unexpected uses such as calming down a group after lunch and association games with a group.
Focus group results	System usefulness and application varied from person to person, but some users were engaged for 3–4 hours at a time. Interactivity would contribute to the experience.	Care professionals were not very fond of the system. However, the system was used as a conversation starter once, which was deemed positive.	Care professionals were enthusiastic about the system; it could easily become a standard tool in day programmes. The system was used for many purposes in various ways.

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an even more engaging experience. In addition, this means that the system could cater to a wider spectrum of users, and that those, for example, in a less advanced state of dementia might be more engaged with the system with the addition of interactive aspects. This extension could also increase the engagement of people with dementia by stimulating play (Anderiesen et al., 2015). In addition, in case studies 2 and 3, we found that the selection of experience modules should be increased. The selection is currently limited and more options would be desirable.

Currently, additional experience modules are being developed and released by the company that created the system. In this way, they are able to quickly broaden their offering and improve the overall experience of the system. For more radical conceptual improvements, for example adding interactive games, development will take longer. However, based on the findings in this study, the company is already developing new conceptual extensions to their system.

Discussion

Over the course of three case studies, we demonstrated the potential of a design-driven approach to living labs. Earlier living lab studies have included active user involvement, for example through co-creation (Sanders & Stappers, 2008). However, by adding design characteristics such as exploration and dealing with uncertainty, living labs can be refocused to better deal with complex problems such as dementia care. In this study, we contributed to answering our research question: *How can we implement a design-driven living lab to explore innovation for dementia care challenges?* The design-driven approach allowed us by actively involving care professionals to broaden the value proposition of the Qwiek.up system, explore the context of dementia care, repurposing the design, and find new opportunities for innovation.

The design-driven living lab approach uses a fully operational system that is presented as a technology probe. This is a high-quality product – rather than a functional prototype – that can be used to explore latent needs, new uses, and opportunities for innovation beyond the evaluation of the current product. This different perspective on putting innovative systems in a real-life context is based on design approaches such as needsfinding, conceptualization, and opportunity seeking (Krogstie, 2012). Today's technology enables the creation of high-quality products in a shorter amount of time, making it possible for in-context studies to influence the value proposition and market release specifications – resulting in shorter innovation cycles. This approach enables fast learning, for example, as was apparent in the redesign of the experience modules or the interface of the Qwiek.up system. This work can be done in a short amount of time, leading to a market release that improves the product offering. Nevertheless, for larger design improvements, such as adding interactivity or answering new use environments such as for children with autism, follow-up design processes are needed, which will take longer to conduct.

Involvement of users in the design-driven living lab is inspired by co-creation (Bergvall-Kåreborn & Ståhlbröst, 2009). However, instead of focusing co-creation efforts in a controlled session, we apply a co-creation perspective during the entire in context study. This allowed participants greater freedom in using the concept, and it allowed us to be more open in interpreting the results. As a result, the participants maintain an open attitude throughout the study, allowing additional insights to emerge such as, for example, new applications or opportunities for meaningful activities in a dementia care context. This was notably demonstrated during the third case study, in which the system was clearly used in an unrestricted and explorative way by the users (Valk et al., 2012). In this case, the users felt they had the freedom to use the system as they saw fit and experimented with it in their specific care settings. This approach also allowed the company to find new uses for the system and orient towards new opportunities in care innovation.

Navigating the early stages of innovation often seems challenging, and this is also the case for living lab practices. However, the inclusion of design skills, such as dealing with opposing perspectives, offers concrete tools to do this (Koskinen et al., 2011). In this study, we have shown that an explorative approach with technology probes can enable the identification of needs beyond the original value proposition and inspire new innovative solutions. The suggestion to facilitate play within the system, for example, allows the company to widen the market impact of the system.

Further research

This article presented an initial application of the design-driven living lab. However, the exact characteristics of this phenomenon are unclear and need to be investigated in greater depth. For example, the system used in this study was arguably already purposed for a

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care context and did not allow for an open-ended exploration in the same context. The effect of different development levels of prototypes/products needs to be further evaluated.

In addition to our insights, we found some limitations in our application of the design-driven living lab approach. We see that, based on our three case studies, there is scope to improve the evaluation method and the design-driven approach. There are, as yet, no best practices for design-driven living labs, and the evaluation methods we used had some limitations. Some users even stopped filling it in regularly after a week into the study because they felt it was too boring. The participants might need more motivation to explore the new technology and more in-depth evaluation forms with fewer intervals might maintain interest. Additionally, alternative ways to capture an open-ended experience, such as diary studies, might be applied. The report provided by the users in case study 3 provided much richer insights into their experience. Also, the more open approach of the focus group methodology made it possible to do more than just capturing experiences and, in addition, allowed for discussion of other topics, such as design opportunities. An important aspect we discovered is the attitude of the users, as we saw in case study 3, where it was reflected in the participants' willingness to experiment. To clarify this aspect, further research is needed on methodologies that can be used to engage users in open and explorative studies as part of a design-driven living lab.

In the future, we aim to create more diverse forms of the design-driven living lab in order to explore its potential for innovation. In this regard, we aim to target the complexity of other societally relevant challenges and emphasize the inclusion of more diverse stakeholders.

Conclusions

Over three case studies, we demonstrated the potential of a design-driven living lab approach. Participants were invited to openly and freely use a new system in their professional context of caring for people with dementia. The results show that the type of feedback obtained can indeed go well beyond an evaluation of a particular design, however, this still needs to be explored further. New insights can be obtained for repurposing the design and defining new value propositions. A design-driven way of performing a living lab makes it possible to extend the boundaries of the approach from evaluation to include exploring innovative solutions. It shows that there is potential for more disruptive, open-ended development of innovation.

In this way, we succeeded in implementing a first iteration of a design-driven living lab. It allowed us to explore both the method and the contexts in which the intervention was applied. The evaluation results are more open-ended, with more room for input from the various stakeholders. The intervention was not evaluated on its effectiveness but rather as an opportunity and, as a result, it strengthened the value proposition and the business case. This was evident in the response by the company, which has included our findings in their system and development processes. Overall, our approach shows that there is potential for navigating the early stages of future innovation processes with developed products designed to address complex societal challenges.

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Keywords: design, living lab, societal challenges, technology probe

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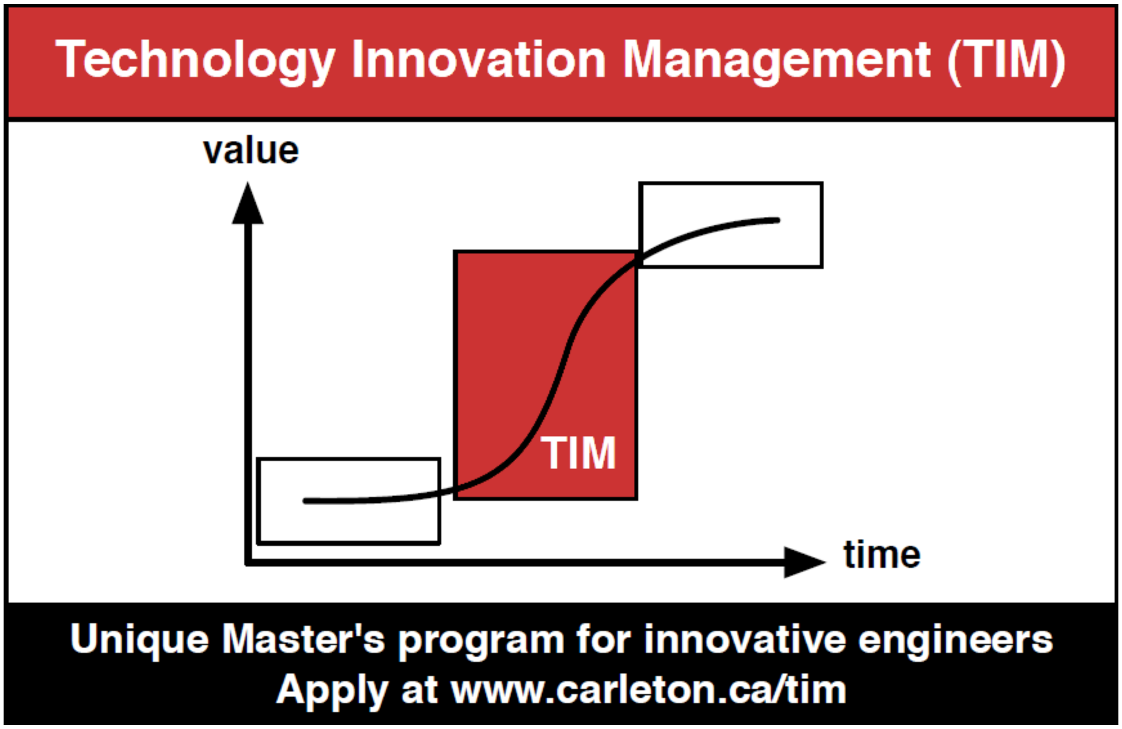

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