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Editorial Introduction

Living Labs: Concepts, Tools and Cases

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Introduction

Praxis and theory

This special issue on "Living labs: concepts, tools and cases" comes 10 years after the first scientific publications that defined the notion of living labs, but more than 15 years after the appearance of the first living lab projects (Ballon et al, 2005; Eriksson et al., 2005). This 5-year gap demonstrates the extent to which living labs have been a practice-driven phenomenon. Right up to this day, they represent a pragmatic approach to innovation (of ICTs and other artefacts), characterised a.o. by experimentation in real-life and active involvement of users.

While there is now a certain body of literature that attempts to clarify and analyse the concept (Følstad, 2008; Almirall et al., 2012; Leminen et al., 2012), living lab practices are still underresearched, 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). The present special issue aims to assist in filling that gap.

This does not mean that the development of living labs has not been informed by scholarly literature previously (Ballon, 2015). Cornerstones include von Hippel's (1988) work on user-driven innovation, because of its emphasis on the ability of so-called lead users, rather than manufacturers, to create (mainly ICT) innovations. Another cornerstone is Silverstone's (1993) theory on the domestication of ICTs that frames technology adoption as an ongoing struggle between users and technology where the user attempts to take control of the technological artifact and the technology comes to be fitted to users' daily routines. It has been said that, in living labs, von Hippel's concept of user-driven design and Silverstone's insights into the appropriation of technologies are coupled dynamically through experimentation (Frissen and Van Lieshout, 2006).

The concept of stigmergy, which refers to addressing complex problems by collective, yet uncoordinated actions and interactions of communities of individuals, has gradually become the third foundational element, as social media have provided online platforms for stigmergic behaviour, which has subsequently been linked to the 'spontaneous'

emergence of innovations (Pallot et al, 2010; Kiemen & Ballon, 2012). A fourth cornerstone is the literature on open and business model innovation, which argues that today's fast-paced innovation landscape requires collaboration between multiple business and institutional stakeholders, and that business should use these joint innovation endeavours to find the right 'business architecture' (Chesbrough, 2003; Mitchell and Coles, 2003).

Definitions

Combining these strands, living labs typically refer to co-creation and appropriation of innovations by users, often in an (online or offline) community setting, and involving also business stakeholders. Over the years, multiple definitions of living labs have been proposed.

Initial definitions included "a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts" (Eriksson et al., 2005) and an "experimentation environment in which technology is given shape in real life contexts and in which (end) users are considered 'co-producers'" (Ballon et al., 2005). Subsequently, these aspects were combined so that living labs were conceptualised as both a methodology and a milieu for organising user participation in innovation processes (Bergvall-Kåreborn et al., 2009).

Almirall and Wareham (2011) emphasise the (productive) tension between the characteristics of the real-life environment in which experiments and observations take place, and the research space that is grafted onto it. They see living labs as "semi-partitioned spaces in the form of innovation arenas integrated in real-life environments but separated by means of an innovation project structure that cultivate user-led insights" whereby the lab is able to "surface tacit, experiential and domain-based knowledge such that it can be further codified and communicated". According to whether the balance is tilted in favour of the real-life environment, in which events happen spontaneously, users have a lot of autonomy and the full context is observable, or a more structured, formalised and controlled research environment, Følstad (2008) identifies two general living lab 'archetypes': living labs supporting context research and co-creation, and living labs as testbeds (cfr. infra).

Other authors have emphasised the institutional dimension of living labs, as entities which are part of an 'innovation system'. For instance, Fulgencio et al. (2012) define a living lab as a "human-technology interaction innovation entity utilizing a mix of methods, tools and principles drawn from known disciplines (design, science, ict, etc.) and set in a real environment and on a local/societal scale". This has added to the proliferation of diverging uses of the term 'living labs'. Dutilleul et al. (2010) even mention five different meanings for which the concept is used: an innovation system, a real-life social setting, an approach for user involvement in innovation, an organisation facilitating living lab approaches, and the European living lab 'movement'. And Westerlund and Leminen (2014) identify no less than eight different research avenues researchers have taken to conceptualize living labs.

Therefore, the most effective way of characterising living labs is probably to analyse actual experiences, and how they evolved over time. Such analyses should not limit

themselves to activities carrying the name of living labs, but also look at similar concepts and how they are put into practice. At least three important predecessors for the living labs-movement as we know it today can be discerned (Schuurman, 2015). The cooperative design movement, or the Scandinavian tradition of user involvement in IT design processes (Ehn, 1989), can be traced back as far as the 1970s, in the 1980s there were the European 'social experiments' with IT (Oestmann & Dymond, 2001; Qvortrup, 1987), and from the 1990s onwards 'Digital City'-projects started to blossom (Paskaleva, 2011). Then, towards the end of the 1990s, the proper living lab concept came into use, first in a US setting (which mostly conformed to Følstad's archetype of living labs as testbeds), but soon primarily in a European setting (which were mostly in line with Følstad's archetype of living labs as means to research context and to enable co-creation).

Predecessors of Living Labs

Cooperative design: the Scandinavian tradition of user involvement

The tradition of cooperative design can be traced back to the 1970s, when research projects on user participation in systems development took place all over Scandinavia (Bødker, 1996). These early initiatives were supported by trade unions and involved workers in the design of IT applications in the workplace (Bjerknes et al., 1987). The 'collective resource approach' that was used, involved collaboration between the organization's workers and researchers, so that researchers were able to gather data and workers were empowered to influence the implementation of IT systems in their daily work context (Fowles, 2000). Key within cooperative design was the collective build-up of resources and knowledge. One of the aspects mentioned in Bødker and Grønbæk (1991) was the facilitation of trial use situations as part of the design process, so as to stage users' hands-on experience with future applications.

This tradition has been extended and modified by other movements, which usually had in common a 'social shaping of technology'-focus, trying to steer and optimize innovations based on user needs and wants, and employing sometimes a 'socio-deterministic' view on innovation (Gasson, 2003).

The subsequent North-American participatory design movement was one of these movements that partly built upon the Scandinavian initiatives in cooperative design (Greenbaum & King, 1991). Participatory design was debuted by computer engineers and developed into a set of theories, practices, and studies related to end users as full participants in activities leading to software and hardware computer products and computer-based activities (Muller & Kuhn, 1993; Bødker et al., 2004).

Since information technology later became prevalent not only at work, but also at home, in school, and even while 'on the move', participatory design has struggled somewhat to embrace the fact that much technology development no longer happens as design of isolated systems in well-defined communities of work (Gasson, 2003). As a result, the so-called user-centered design-approach (UCD) came to the fore. UCD can be characterized as a multi-stage problem solving process that not only requires designers to analyze and foresee how users are likely to use a product, but also to test the validity of their assumptions with regard to user behavior in real world tests with actual users.

This design methodology looks at the design of a product or service as a process in which the needs, wants, and limitations of users are given extensive attention at each stage of the design process, including testing in field studies. The three principles of UCD became an early focus on users and tasks, an empirical measurement of product usage in field trials, and iterative design (Gould & Lewis, 1985).

Commonly used methods include ethnographic studies, contextual inquiry, prototype testing, usability testing and generative methods. Contextual inquiry, as a part of the 'contextual design' methodology, also evolved out of the cooperative and participatory design traditions, and focuses on the design of products or services within their actual usage context. Ethnographic techniques, such as observing and interviewing users during their normal daily-life routines, were prevalent in these traditions (Wixon, Holtzblatt & Knox, 1990; Holtzblatt & Beyer, 1995).

Social experiments: field trials with IT in Europe

A second line of proto-Living Labs started in the 1980s when all over Europe various social experiments with information technology were started. 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. They are usually designed to test an intervention or treatment whereby the test is seen as the evaluation of a global package of many components, rather than as a uni-dimensional causal construct (Cook & Shadish, 1994). Under impulse of the European Commission and the FAST-programme, researchers started to use social experiments as a test and implementation methodology in the context of the developing field of ICT in the 1980s. Qvortrup (1987) defines these social experiments as specific forms of ICT implementation in which the primary goal is to establish new forms of organization using IT, with a view to influencing the society at large. Some examples of European social experiments with ICT include field trials with Interactive Videotex (France, Germany, UK and Denmark), Broadband Cable and Computer Conference Systems (Ancelin, 1987), and the implementation of so-called telecentres for rural ICT-development in various European countries (Oestmann & Dymond, 2001).

The appeal of social experiments, together with the European policy and funding support, resulted in a strong growth of initiatives being awarded the 'social experiment' label without much further consideration (Qvortrup, 1987). In an attempt to delineate the concept somewhat, Ancelin (1987) added that social experimentation is an open-ended process in which there are several degrees of freedom and in which a mutual learning process for the promoter and for the user is facilitated. The key to the mutual learning process involving supplier and user is their consequent mutual adaption. The responses of the users provide indications for the development of new technological applications, and these new applications in turn influence the users' behavior, giving rise to 'social inventions' (Hartley (1987). This indicated a shift towards a 'mutual shaping' view on ICT development instead of the dominant 'social shaping' view of the cooperative design approach of the 1970s. The role of the end-user was considered important in these initiatives, but there was no conclusive stance about the nature of

this role: users could function as mere testers or respondents, but could also be involved on equal footing (co-creators) or as innovators themselves.

Digital City initiatives

During the 1990s, the 'digital city' concept took hold in Europe and elsewhere, referring to a number of digital initiatives undertaken by cities, especially related to digital representations of the city and the provision of internet access for citizens. Digital cities can be seen as the counterpart of the telecentres that were set up for social experiments, which were often aimed at underprivileged, rural and remote areas. The digital city network infrastructure and the platforms used to disclose the large amount of digital information were of central importance within the digital city-discourse, causing the concept to carry a quite heavy technology-deterministic connotation (Ishida, 2000; Mechant et al., 2012).

Some examples of these early digital city-initiatives could be found in the Netherlands (Digital City Amsterdam, founded in 1994) and in Finland (Virtual Helsinki, founded in 1996). But also in the US, AOL started a regional information service called "digital city" for several tens of major US cities, while in Japan, the Digital City Kyoto Project was launched in 1998 to create a "social information infrastructure towards the 21st century". Many initiatives aimed to bring together digital information about cities and citizens, and make it accessible in a public virtual space where citizens could consult this information but also interact with it, and (increasingly) with each other (Loukis et al., 2011). This last aspect, interaction with each other, is also referred to in other definitions of digital cities that stress the connectivity between various stakeholders in a city context (Ergazakis et al., 2011; Middleton & Bryne, 2011).

Current smart city-initiatives can be seen as either extensions of the large-scale technology infrastructure and platform initiatives, now encompassing also mobile technologies and the so-called internet of things, or as attempts to strengthen the cooperative and participatory strand, both present in the original Digital City concept (Breuer et al, 2014).

The digital city-initiatives were, more than the previous two predecessors, explicitly multi-stakeholder as they connect citizens (users), policy makers (public organizations) and private organizations (businesses) on a large scale. Thematically, the initiatives covered a broad range, albeit always with a link to city life. In terms of user involvement, the user was seen as a potentially innovative agent, with the technical infrastructure as a trigger for this creativity.

From Home Labs to Living Labs

The MIT vision

While there had been 'accidental mentions' of the term living lab before – mostly as wordplays used to indicate the 'in situ' nature of different types of biology, medicine and other research (Schuurman, 2015) -, the actual birth of the concept is ascribed to MIT's prof. dr. Mitchell, who used it to refer to a purpose-built lab where the routine activities and interactions of everyday home life can be observed, recorded for later analysis, and

experimentally manipulated, and where volunteer research participants individually live in, treating it as a temporary home (Eriksson et al., 2005). These labs had an initial focus on testing and adapting new technologies based on their fit with the daily home environment. This is not to say living labs were originally the same as so-called 'smart home' projects: whereas the latter type of projects acts mostly as a showcase of the 'home of the future', a living lab had as primary goal to research how ubiquitous computing technology can be designed to fit the daily lives of the living lab inhabitants (Markopoulos & Rauterberg, 2000). In these home labs, the user is mostly involved as a passive study object within a testbed setup.

In the MIT PlaceLab, a 1000 square foot 'living laboratory', with all facilities of a regular home, users are observed, logged and tracked with all sorts of devices, allowing to record their habits, activities and routines (Intille et al., 2006). Strong importance is placed on the technical infrastructure allowing the data gathering. In terms of methodology, this makes the living lab an extension of usability tests, aiming to get more accurate and realistic user information by having more long-term data, allowing observation of everyday activities and capturing tacit knowledge (Pierson & Lievens, 2005). In Europe, there are also some well-known examples of living labs similar to the MIT set-up, i.e. the Philips Homelab in the Netherlands (which opened already in 2002) and the Fraunhofer InHaus in Germany. The StudioHome in the ID-StudioLab of the Delft University of Technology even moves the furniture and changes the interior to match the outlook of the individual user's own home (Pasman et al., 2005).

European living labs

When living labs appeared in Europe in the first years of the 2000s, it became clear that the living lab notion that was to be predominant in Europe, and that built upon the earlier experiences with participatory design, social experiments and digital cities from the 1970s up until the 1990s, offered a fundamental reinterpretation of the US-originated home labs. A major divergence was that the user was to be studied in his or her everyday habitat instead of recreating a natural context in a laboratory setting (Niitamo et al., 2006). In terms of methodological set-up, this implied bringing the testing facilities to the users instead of the other way round.

It can be argued that the European understanding of living labs as a set of methods and a milieu for leveraging user-technology reactions and interactions in the innovation process (cfr. supra) combined five basic elements that reflect a number of aims and characteristics of both the home labs and the living lab predecessors (see also Følstad, 2008; Schuurman et al, 2012). These elements are active user involvement (i.e. empowering end users to thoroughly impact the innovation process), a real-life setting (i.e. testing and experimenting with new artefacts 'in the wild'), multi-stakeholder participation (i.e. the involvement of technology providers, service providers, relevant institutional actors, professional or residential end users), a multi-method approach (i.e. the combination of methods and tools originating from a.o. ethnography, psychology, sociology, strategic management, engineering) and co-creation (i.e. iterations of design cycles with different sets of stakeholders). This combination of elements from previous experiences is summarised in the table below.

Table: Aims and characteristics of living lab predecessors

	Cooperative Design (70's)	Social Experiments (80's)	Digital Cities (90's)	Home labs (00's)
Active user involvement	+	+/-	-	-
Real-life setting	+	+	+/-	+/-
Multi-stakeholder	+/-	+	+	-
Multi-method approach	+/-	+	-	+/-
Co-creation	+	+/-	-	-

In 2006, the European living labs movement gained momentum through a set of EU policy measures (Dutilleul et al., 2010), including the funding of 'Corelabs' and 'Clocks', two projects aimed at promoting and coordinating a common European innovation system for ICTs based on living labs, and at hosting and promoting the establishment of the European Network of Living Labs (ENoLL). This initially consisted of 19 living labs located across the EU. Living labs were also explicitly supported in the 'Strengthening innovation and investment in ICT research'-pillar of i2010, the EU policy framework for the information society and media (Peltomäki, 2008).

The so-called Helsinki Manifesto (2006) described ENoLL as a platform for knowledge sharing and collaboration to foster common methodologies and tools across Europe that support, stimulate and accelerate co-creative innovation processes, relying on users involvement. The EU Commission allocated a significant budget in order to promote the development of ENoLL (Prime Minister's Office, 2006). Originally, ENoLL consisted only of European initiatives that were admitted to the network after a benchmarking exercise, but it has grown to include members from a.o. Brazil, Colombia, Canada, Mexico, Australia, China and Egypt. The criteria used during the evaluation process for prospective members refer to the organisational set-up, openness, resources, user involvement and real-life facilities, and value creation potential of the initiative (Dutilleul et al., 2010).

While the number of living labs that have been evaluated positively by ENoLL since 2006 amounts to over 300, not all of these initiatives are still around. Many living labs are only established to carry out a single innovation project (Ståhlbröst, 2012), while others have found it impossible to maintain a sustainable operation while being dependent on project-funding. It is estimated that between 35% and 40% of the labs who successfully applied for the ENoLL benchmarking, are currently no longer active (Schuurman, 2015).

Recent Developments and Outline of the Special Issue

Despite the sustainability challenges of a number of individual initiatives, living labs have gradually become an established part of (ICT) innovation policy. Not only is the set-up and involvement of living labs by now requested in innovation programmes at EU level in regular fashion, but they also appear in innovation policy measures and programmes at the level of individual member states and regions, including Finland, the Netherlands, all three official regions in Belgium, Spain, Slovenia and others. Also, the Worldbank has started to promote living labs worldwide as an innovation policy tool for developing countries (Garcia et al., 2010; Hirvikovski, 2012; World Bank & ENoLL, 2014).

Despite the common frames of reference mentioned earlier, there is a still a large heterogeneity of living lab initiatives (Ballon, 2015; Schuurman, 2015). In terms of organisational set-up, living labs encompass a range of (semi-) permanent as well as temporary projects associated with academic institutes, large technology vendors, municipalities or non-profits, innovation consultants, design or marketing companies, industry clusters, and so on. The number of users involved in living lab testing and experimentation ranges from a handful (e.g. in some homecare living labs that necessitate the installation of complex or costly equipment in users' homes) to several thousands (e.g. in the case of large online or offline communities of practice involved in living lab trials). A number of living labs have turned predominantly to information retrieval and crowdsourcing online, using social media as a living lab environment. Others have extended their scope to treat entire (parts of) 'smart cities' as living labs, making use of mobile, location-based social media and sensor network data. Many questions related to the nature and characteristics of living labs, their methods and effectiveness, their application domains and new avenues for research, are still open (Azzopardi and Balog, 2011; Schaffers et al., 2011; Ballon, 2015).

This special issue brings together a selection of expanded, rewritten and re-reviewed papers that were presented, in earlier form, during the annual European Network of Living Labs Research Day in Amsterdam, the Netherlands (September 2014). We especially thank Ana Garcia, the Head of Office of ENoLL, for the organisation of the event and the help in getting out the call for papers; the conference participants who provided feedback on the presented papers in relation to the Veli-Pekka Niitamo memorial award for best research contribution; as well as the many anonymous reviewers involved, both for the ENoLL Research Day and for this special issue.

The papers gathered here reflect some of the most salient issues related to the topic of living labs. The first two papers deal with some of the most important 'traditional' challenges to living labs. The first paper, by Mastelic, Sahakian and Bonazzi, discusses ways to improve the sustainability of living labs. The paper explores how living labs might be evaluated based on criteria related to their business architecture. It finds that three elements are currently missing or under-represented in the ENoLL evaluation system, i.e. the cost structure, customer segments and the revenue stream. For the 'sustainability' of a living lab, the paper argues that a strong business model is needed, based on a long-term strategy that considers funding structures, target audiences, and revenue sources, all of which must be assessed not only at one moment in time, but over time, in a continuous and dynamic process involving different stakeholders.

The second paper, by Georges, Schuurman, Baccarne and Coorevits, treats the refinement of methods for active user participation of Living Labs. Based on the analysis of three living lab cases in which field trials were organized, the authors identify several factors playing a role in the engagement of users. An influential factor that emerged is the functional maturity of the innovation, i.e. the extent to which a prototype resembles the functionalities and the processes of the final, go-to-market product at the moment of the field trial. A 'user engagement model for field trials' is proposed, as well as six concrete guidelines to better involve end-users in living labs.

The following two papers address cases studies of specific living lab projects that expand our knowledge related to specific application domains. The paper by Brankaert, den Ouden & Brombacher examines the case of several living lab tests related to the technological assistance of people suffering from dementia, and summarizes the approach into a living lab protocol that allows for involving cognitively impaired people and their caregivers in their natural context. It also provides suggestions to overcome issues of informed consent/willingness to participate, safety & security and adequately addressing of needs for people with dementia.

The paper by Franz on living labs in urban research considers the application of living labs to large-scale social-spatial issues. It argues that living labs have the potential to be an instrument for the active inclusion of citizens in urban research projects investigating socio-spatial questions. It examines the possibilities and limitations of implementing living labs with public authorities as 'producers' and citizens as 'users', and identifies current approaches and gaps in living lab design.

The final set of papers focuses on living labs at the service of specific private businesses. The paper by Lapointe and Guimont starts from the premisse that many living labs aim to operate as open innovation ecosystems that include various private stakeholders, but that literature does not tell us much about their modus operandi or about the way in which they conceive open innovation. Lapointes paper focuses on the relationship of private stakeholders to open innovation in the context of in-situ activities and establishes a typology of businesses in relation to open innovation.

Lastly, Salminen, Rinkinen and Kahn examine how to support use of design in SMEs by developing a new design support service. The authors take two basic assumptions as a starting point: (1) using design is beneficial for SMEs' business and (2) business advisors are the best channel for reaching these SMEs. Many countries have launched projects to address this issue and have devised solutions to support SMEs in this context. The paper analyses one such initiative, which focused on the potential of the business advisors to bridge the gap between SMEs and design service providers. Their study provides insights into the discussions on service development projects realized in the living lab environment that enhance the use of design services among SMEs. The case study and its findings presented in the paper highlight the need to focus on service users in the early phase of the service design process instead of utilising user knowledge only in the testing phase. Co-creation and co-design processes with users instead of only with assumed experts in the field provide wider possibilities and fruitful base for service development.

Together, we hope the papers gathered here provide an excellent contribution to the scholarly debate on living labs for anyone interested in user-driven and open approaches to ICT innovation.

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