Living Labs: a systematic literature review

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Keywords: Living Labs, Open Innovation, User Innovation, Literature review, Innovation

Abstract

This paper presents a systematic literature review of the body of scientific Living Labs literature. Based on a general review of the Google Scholar and Web of Science databases, we can conclude that the Living Labs movement in terms of theory and research has taken off since 2006 in quantity of published papers. However, in terms of quality and impact, the academic field of Living Labs is still rather insignificant. An analysis of the 45 most cited papers reveals that the practice-based side is much further developed than the theoretical side, with only few references to more established innovation theories such as Open Innovation and User Innovation, despite the fact that concepts from both literature streams are present in all papers. Strikingly, 18 out of 45 papers refer to no framework at all, remaining merely descriptive. There is also a lack of empirical, more quantitative and comparative studies that focus on the added value of Living Labs. This paints the picture of Living Labs as a research domain in development which calls for a better anchoring within more established innovation theories in order to advance the field.

Introduction

The official birth of the European Living Labs movement is often situated in 2006, the year the European Commission officially declared its support by stimulating projects to advance, coordinate and promote a common European innovation system based on Living Labs (Dutilleul et al., 2010), and also the year in which the European Network of Living labs (ENoLL), was established an organization aimed at connecting Living labs for knowledge exchange, networking purposes and the development of a shared innovation concept (European Commission, 2013b). Despite the fact that Living Labs have been around for nearly a decade, in terms of conceptualization, the current literature stream is still inconsistent and sometimes contradictory. Følstad (2008a) identified nine living lab characteristics, of which five were diverging, which indicates a large variety of approaches being labeled as living lab. Moreover, a second literature review two years later by Dutilleul et al. (2010) revealed five different meanings given to discern living labs in the papers they studied: 1. an **innovation system** consisting of organized and structured multi-disciplinary networks fostering interaction and collaboration; 2. real-life or **'in vivo' monitoring** of a social setting generally involving experimentation of a technology; 3. an **approach for involving users** in the product development process; 4. **organizations facilitating the network**, maintaining and developing its technological infrastructure and offering relevant services; 5. **the European movement** itself. Most recently, Westerlund and Leminen (2014) even found eight different perspectives on Living Labs. However, to this date, a structural and systematic analysis of the Living Labs literature is missing. Within this paper we wish to fill this gap by using a clear methodology for selecting and analyzing the current body of Living Labs papers and articles. This allows to identify the main perspectives and viewpoints on Living Labs and how they have been embedded within the more established innovation theories.

2 Methodology

In order to get an overview of the State-of-the-Art of academic and empirical research into Living Labs, we conducted an exploratory review of the available literature. Hereto we constructed a sample of the most cited Living Labs papers. We used the Google Scholar academic search engine[1] and looked for articles by using the search string "Living Lab" (end of October 2014). This yielded more than 6.500 results. Subsequently, we narrowed the number of articles down by only including articles where "Living Lab" was mentioned in the title in order to weed out the articles where "Living Lab" appeared 'accidentally' or only occurred on a side note. This resulted in 563 articles. From this sample, we chose to include only journal or

[1] http://scholar.google.be/

conference papers (excluding books, book chapters, theses or other citations) with a direct link to the abstract and only articles with a citation count of more than 10. This led to a total sample of 45 articles (see attachments for the full list). In order to get an overview of the number of Living Labs papers in top ranked journal, we did a similar exercise in the Web of Science database, looking for all articles that had "Living Lab" in the title. This led to 50 articles in total. In the following table we give an overview of the total number of articles from our three searches, organized per year. In terms of time intervals, we used 2006 as an anchoring point, as this year marked the establishment of the European Network of Living Labs and more formal support for Living Labs from the European Commission. The papers published before 2006 were merged into one category, while we give an overview of the rest of the sample per year.

Table 1: Sample overview per year (October, 2014)

Publication year	Articles in sample (Google Scholar + 10 citations)	Articles in total (Google scholar)	WoS articles
Until 2005	4	18	3
2006	3	9	0
2007	5	15	3
2008	7	52	3
2009	6	69	8
2010	9	74	8
2011	5	65	6
2012	4	95	7
2013	2	92	8
2014	0	74	4
Total	**45**	**563**	**50**

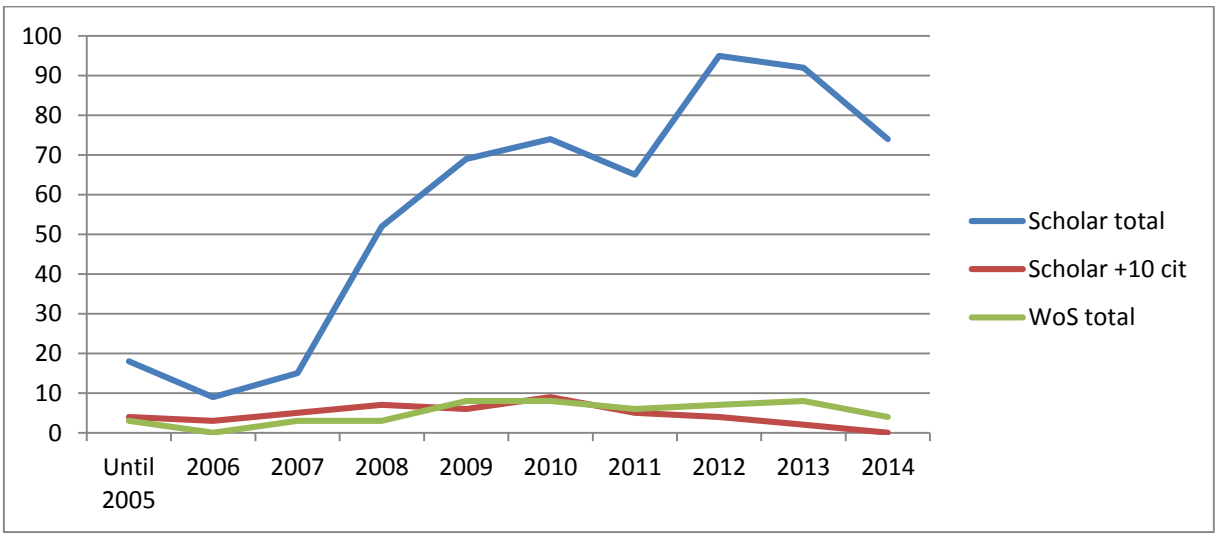

Figure 1: Living Labs papers evolution

In terms of the total articles, we see a clear 'explosion' of research after the establishment of ENoLL, somewhat similar to the growth of ENoLL itself in the first years. The years 2009-2011 seemed to mark a stagnation in the number of published papers, whereas 2010 was the top year of new Living Labs entering the network. However, as the number of new Living Labs started to drop significantly from 2011 onwards, the number of papers started to increase again in 2012 and seems to have stabilized again. What looks more problematic, is the evolution of papers that effectively generate impact. In terms of papers with a citation count of more than 10, no year has yielded more than 10 papers, with a maximum of 9 papers in 2010 being cited more than 10 times.

In terms of Web of Science-papers, we also get the image of a research field 'in development'. When we select all articles in the Web of Science database that have "living lab" in the title, this results in only 50 papers that have been published in journals (21) or conferences (29) that are abstracted in this influential database. This is only a fraction of the almost 600 papers with Living Lab in the title from the Google Scholar-search. Moreover, when we look at the citation count of these papers, only 2 have more than 10 citations in other WoS-publications: Wolfert et al. (2010) with 24 citations and De Moor et al. (2010) with 11 citations. The majority of the WoS publications (33) even has no citations at all. Moreover, the overlap with our Google Scholar most cited sample is rather scant, with only 8 papers appearing in both list (cf. also the attachments): Budweg et al. (2011), De Moor et al. (2010), Hlauschek et al. (2009), Liedtke et al. (2012), Schuurman et al. (2011), Svensson et al. (2010), Wadhwa (2012), and Wolfert et al. (2010).

Therefore, we decided to continue our analysis with the top-cited Google Scholar articles. For the 45 Google Scholar papers with a citation count higher than 10 the total citation count is 1943, which means an average of 43 citations per paper. Only 5 papers are cited more than 100 times: Abowd et al., 2002 – 135 cit.; Eriksson et al., 2005 – 176 cit.; Niitamo et al., 2006 – 142 cit.; Almirall & Wareham, 2008 – 124 cit. and Følstad, 2008 – 182 cit. Note that none of these papers is also on the WoS.

For Open Innovation, West & Bogers (2013) conducted a similar literature overview which resulted in 287 papers in SSCI journals (Web of Science papers), with the first 10 papers being cited at least 500 times, with Chesbrough's book (2003) even cited more than 8000 times, and Chesbrough being (co-) author of most of the top-cited papers. The same is true when looking for literature with the terms 'User Innovation' and 'lead user', with von Hippel as a dominant figure and easily more than 10 articles with over 400 citations, although the Open Innovation literature is clearly dominant in terms of quantity.

Based on these general statistics, we can conclude that the Living Labs movement in terms of theory and research has taken off since 2006, at least in quantity of published papers. However, **in terms of quality and impact, the academic field of Living Labs is still rather**

insignificant. Regarding the authors, 39 papers were authored by European scholars, five by American scholars and one paper originated from Australia (Third et al., 2011). This is further proof that the Living Labs field is clearly dominated by Europeans. However, there is not a single author very 'dominant' as in the Open and User Innovation literature, with five authors (Almirall, Wareham, Ståhlbröst, Eriksson and Feurstein) (co-) authoring 3 papers. This is also a further indication of a scattered research field. We will continue the rest of our analysis with the 45 Google Scholar 10+ cited papers. We chose to use this sample as it has some clear advantages. The selection criteria are clear and unambiguous, which enables later reproduction (e.g. for future comparative studies). Moreover, the sample size allows to have a more in-depth knowledge of all the papers, while at the same time representing a fair share of the total amount of papers (8%). However, we also acknowledge some limitations that come with our selection methodology. Papers that do not have "living lab" in the title are excluded (e.g. Ballon et al., 2007), although based on our knowledge of the literature, this has only a minor impact. Perhaps more impact is generated by including the criterion of 10+ citations. This tends to limit the inclusion of the most recent Living Labs papers, as it takes some time to get cited by even newer publications. However, this would raise the issue on how to measure or assess the quality of these more recent publications. Therefore, we chose to keep our initial criteria and propose future research should adhere to these criteria to include more recent literature that by that time has reached a significant degree of impact.

3 Results & discussion

When going through all the papers, two important issues arise. First, only a small minority of the papers reports on well-grounded empirical research on Living Labs. The majority of the papers are descriptive single or multiple case studies, or conceptual papers relying on desk research, without a rigid methodology being used or explained.

In our sample, 18 out of 45 papers are merely project descriptions with only limited conceptual value (Abowd et al., 2002; Baida et al., 2007; Schwittay, 2008, Hlauschek et al., 2009; Krieg-Brückner et al., 2010; Hess & Ogonowski, 2010; Budweg et al., 2011, Schuurman et al., 2011; Liedtke, 2012; Wadhwa, 2012; Schwartz et al., 2013; Ogonowski et al., 2013) or they describe a single case study where a 'Living Lab approach' is used, but without Living Labs themselves being the subject of the research (Haymaker & Chachere, 2006; Scott et al., 2009; Wolfert et al., 2010; Bliek et al., 2010, Ryu, 2010; Third et al., 2011). Remarkably, all American papers and the single Australian paper are to be found in this category, which is another indication that Living Labs are largely a European phenomenon. Also, the Ryu (2010) paper is the only downright negative paper in the whole sample, as it describes the power relations a large company can exert in the process of ICT introduction in developing countries. All other 44 papers approach Living Labs in a neutral or overtly positive way, which is an indication of the absence of a critical attitude towards Living Labs as a concept. In the Open and User Innovation literature we also encountered mostly positive case studies, but in both fields some critical

papers have also emerged. To this day, no real 'critical' Living Labs paper has been published, which is a further proof of the rather low impact of the field in other literature streams.

Table 2: Living Labs paper type

Paper type	Number of papers
Descriptive papers	18
State-of-the-Art papers	4
Conceptual & methodological papers	16
Empirical paper	7

Subsequently, we can discern a category of four papers that contain multiple Living Lab cases, but merely as high-level descriptions and illustrations. First, we have the oldest paper from our sample by Markopoulos and Rauterberg (2000) who give an overview of the American Living Labs that were blossoming at that time, with also examples from this kind of Living Labs in Europe[2]. Next, we have the widely cited papers by Eriksson et al. (2005) and Niitamo et al. (2006) who give an overview of the developing European Living Labs field, also including some of the American examples. As a fourth paper in this category, we have Schaffers et al. (2007) who discern the Living Labs for rural development, which represents a new type of Living Labs that popped up in practice.

Besides these four 'state-of-the-art' papers, we have a rather large sample (16 or just over 1/3 of all papers) that deal with methodological and conceptual contributions to Living Labs, based on single case studies or purely conceptual papers. Pierson and Lievens (2005), Kusiak (2007), Følstad (2008b), Levén and Holmström (2008), Feurstein et al. (2008), Schuurman and De Marez (2009), Bergvall-Kareborn et al. (2009a&b), Santoro and Conte (2009), Pallot et al. (2010) deal with user contribution and project methodologies for Living Labs. Some papers base themselves on more research data, such as Schumacher and Feurstein (2007) who report on a Living Labs survey, albeit in a very descriptive way. Mulder et al. (2007 & 2008, basically two times the same paper) report on a brainstorming exercise of Living Lab practitioners and map different methods and tools on a 'harmonization cube', while Svensson et al. (2010) base themselves on user contribution in more than 100 user interaction instances in three Living Lab projects to inventarize different methods. Ponce de Leon et al. (2006) and De Moor et al. (2010) deal with testbeds in the context of Living Labs, and how to intergrate these, with De Moor et al. (2010) dealing specifically with Quality of Experience as methodology which can support Living Labs and vice versa.

However, only seven papers dig deeper into the Living Labs phenomenon with a larger sample, a more rigid methodological approach or a more in-depth analysis of the cases studied. First,

[2] Note that the authors were also European and connected to a Dutch Living Lab.

there are two papers containing literature reviews: the Følstad (2008a) and Dutilleul et al. (2010), which we both touched upon briefly in the introductory section. Although their methodology for selecting the papers is not very clear, both articles have been referred to rather often.

3.1 Theoretical frameworks

We also assessed which theoretical frameworks were used in the papers. Therefore we examined the theoretical and introductory parts of the paper and looked which frameworks or paradigms were mentioned as foundations for Living Labs. Building further on Schuurman et al. (2013), we looked for indications of the Open Innovation and User Innovation frameworks, and because of the influence of the cooperative design movement for the early Living Labs (Ballon & Schuurman, 2015), we also looked for indications of these literature streams. In practice, we looked at the occurrence of the 'Open Innovation', 'User Innovation', 'user-centered design' (UCD) and 'participatory design' (PD) expressions, but also for citations of prominent authors associated to the fields such as Chesbrough or von Hippel. The table below gives the numbers of articles where the proposed frameworks are used, together with the number of articles where none of the theoretical foundations were used.

Table 3: Dominant framework

Paradigm	N
Open Innovation	11
User Innovation	17
UCD / Participatory design	19
None	18

Surprisingly, Open Innovation is only explicitly referred to in 11 papers. This can be explained by the fact that in a lot of these papers, terms like open collaboration, Public-Private-People partnership, or even Open Innovation are used without any referral to literature from the Open Innovation domain. **A lot of the Living Labs papers seem to take the use of Open Innovation for granted, without reflecting in terms of the Open Innovation literature base or without apparent knowledge of this literature stream**. Papers like Schuurman and De Marez (2009), Svensson et al. (2010) and Pallot et al. (2010) equal Open Innovation with user involvement and open collaborative innovation, something which was also discussed in West & Bogers (2013). **In 18 articles, none of these frameworks was referred to**, whereas 17 papers referred to the User Innovation literature. The UCD/PD framework is the most cited with 19 papers, which is an indication that **the 'cooperative design' predecessor still has a large influence on the current Living Labs movement**. Moreover, the large amount of papers without reference to these frameworks is remarkable, but also congruent with the previous finding that 18 papers within our sample are for the largest part descriptive without much

attempt at theory building. Among the earlier papers with a reference to design thinking, we find especially American authors with references to participatory design and requirements-driven innovation (Abowd et al., 2002; Haymaker & Chachere, 2006; Kusiak, 2007). In Europe, the Scandinavian authors have maintained a strong connection between Living Labs and design thinking (Følstad, 2008a&b; Levén & Holmström, 2008; Bergvall-Kåreborn et al., 2009a).

3.3 Living Labs and Open Innovation

Referring back to the initial goal for the promotion of Living Labs within the wider European innovation system, which was to help solving the European Paradox, or the imbalance between knowledge exploration and exploitation, we would also expect Open Innovation to be more prominent as framework for conceptualizing Living Labs. In order to 'solve' the European Paradox, Living Labs should be able to facilitate the process of exploitation. Therefore, we looked at the Living Lab definitions, and more specifically the goals that were mentioned for the Living Lab activities that were described in the paper. We coded all papers for the three Open Innovation processes of exploration, exploitation and retention (Lichtenthaler & Lichtenthaler, 2009; van de Vrande et al., 2009):

Exploration: innovation activities to capture and benefit from external sources of knowledge to enhance current technological developments

Exploitation: innovation activities to leverage existing knowledge or technological capabilities outside the boundaries of the organization

Retention: maintaining, storing and reusing knowledge over time outside of an organization's organizational boundaries

Besides the word exploration itself, we considered words such as experimentation, study (of user behavior), testing,… as indicators of exploration goals. For exploitation, we regarded words and phrases like 'creating initial demand', adoption, technology transfer, implement, and business models to refer to an exploitation goal. For retention, indicators such as knowledge and information sharing, multi-stakeholder communication and rethinking were used.

Table 4: Open Innovation processes

Proces	N
Exploration	45
Exploitation	15
Retention	7

All papers (45) define Living Labs and Living Lab activities as an exploration of new knowledge, whereas only one out of three (15) mentions exploitation as a motive for Living Labs. This is a clear mismatch with the original intentions described in the Helsinki Manifesto (2006) of Living Labs as facilitators of knowledge exploitation. The exploitation motive of Living Labs is the most common in the more thematic Living Labs (e.g. Baida et al., 2007; Hlauschek et al., 2009; Wadhwa, 2012) or Living Lab projects where an innovative infrastructure is rolled out amongst a population (e.g. Schwittay, 2008; Ryu, 2010; Third et al., 2011; Bliek et al., 2010; Schwartz et al., 2013). The fact that knowledge retention is the least common is not a real surprise, as this process is also the least studied within the Open Innovation literature. The seven instances where retention was an explicit goal, were in thematic Living Lab constellations where stakeholders from a certain sector intend to collaborate and exchange knowledge regarding future opportunities (Baida et al., 2007; Wolfert et al., 2010), two projects aimed at sustainable innovation with the creation of user awareness (Scott et al., 2009; Liedtke et al., 2009), the literature review of Dutilleul et al. (2010) who refer to the regional knowledge sharing opportunities of Living Labs, and the two papers by Mulder et al. (2007 & 2008) that incorporate the outcomes of a brainstorming session of Living Lab practitioners in an attempt to create shared tool and methodology set for Living Labs. This is an indication of the imbalance in the attention for the Open Innovation processes in the current Living Labs literature. Moreover, the fact that only 11 papers explicitly refer to Open Innovation as a defining paradigm, but that in all papers references to knowledge transfers between actors can be found, suggests that Living Labs are emanations of Open Innovation. This calls for a better conceptualizing of Living Labs that allows to frame them in terms of Open Innovation.

3.4 Living Labs and User Innovation

We now turn over towards the appearance of User Innovation within our sample of Living Labs papers. As within the Living Lab definitions user involvement and user co-creation are essential characteristics, we looked in our sample for the degree of this user involvement. As key framework, we chose the categorization of Kaulio (1998), who discerns innovation/design for, with and by users. *Design for* denotes an innovation approach where user involvement is limited to passive user feedback, gathered through Voice of the Customer-methods or user behavior studies, as were conducted in the American Living Labs. *Design with* denotes an innovation approach based on co-creation, as users and manufacturers work together in an iterative manner, where the locus of innovation can be seen as shared between both involved actors. *Design by* refers to an innovation approach where users innovate themselves, which is in line with the Lead User-approach and the CAP, as the locus of innovation resides with the user.

Table 5: User involvement mode

Design…	N
For users	11
With users	34
By users	0

We looked at all articles and assessed what the dominant mode of user involvement was for the Living Lab activities that were described in the paper, or in the case of conceptual papers how the user contribution was defined. Not surprisingly, design with users, or the co-creation stance, was dominant in the majority of the papers (34). None of the papers described activities where the 'innovation by users'-mode was dominant, although it was described in some papers (cf. infra). However, it is remarkable that the majority of the papers refers to co-creation with end-users, but only 17 papers mention User Innovation as anchoring paradigm. Apparently, the current Living Labs do not support true User Innovation, or at least do not see this as the dominant form of user contribution. Design for users, where the user only plays a passive role in the innovation process, is the dominant mode in 11 papers, including the American Living Labs and the real-life testbeds with passive user observation or simple evaluation, and some papers that deal with Living Lab projects where technologies are rolled out amongst a group of users with technical testing in real-life as main goal.

Regarding the rest of the papers that dealt with the User Innovation paradigm explicitly, we would expect that the roles and characteristics of end-users in Living Labs would be described and researched in greater detail because of the user-centric nature of Living Labs. However, when going through the literature, this was not really the case. Lead User methods are mentioned in the context of Living Labs when overviews of methods to be used are presented (e.g. Pallot et al., 2010; Kusiak, 2007), but how this should exactly be approached remains unclear. In the works of Almirall et al. (2012), the Lead User concept also pops up with no clear specification on how to implement this, except for 'selection of relevant users' (Almirall et al., 2012). The Lead User method is also displayed as separate from Living Labs, with a slight overlap. The same goes for Pallot et al. (2011), who consider the Lead User-method as one of the user involvement techniques that are being used in Living Labs. Interestingly, Almirall and Wareham (2008) consider Lead User entrepreneurs as an important stakeholder group in Living Labs, something which is also mentioned by Pallot et al. (2011).

4 Conclusion

Out of this overview of the theoretical state-of-the-art of the field of Living Labs, we have gathered that the practice-based side is much further developed than the theoretical side. In terms of empirical research and academic publications, Living Labs have received some attention, but this attention is virtually absent in top ranked journals. **There is also a lack of empirical, more quantitative and comparative studies that focus on the added value of**

Living Labs. In the Living Labs literature, neither Open nor User Innovation is the dominant paradigm. Referring back to the Living Labs predecessors, it is the User Centered Design that originated from the Participatory Design movement that is still dominant. Strikingly, 18 out of 45 papers refer to no framework at all, remaining merely descriptive. User Innovation occurs more frequently than Open Innovation, but it seems that in recent papers Open Innovation is more and more adopted within the Living Labs literature. This is in line with the trend we also discovered in the previous chapter on Living Labs practice, where we noticed the emergence of a new type of Living Lab constellation, based on multi-stakeholder collaboration and knowledge sharing, rather than on user involvement.

However, in the Living Labs papers that deal with Open Innovation, for the most part this is equaled to open collaborative innovation, as it is argued that Open Innovation stresses user involvement and that Open Innovation takes place in a process of co-creation with internal and external parties. This ignores Open Innovation processes such as licensing and buying, which do not involve any form of co-creation at all. For example, this is also apparent in Westerlund and Leminen (2011) who see Open Innovation as a driver for user involvement and mention open source and crowdsourcing as alternatives to conventional in-house development. Based on their research, we proposed five distinct stakeholder roles within Living Labs: users, utilizers, providers, enablers and researchers. Despite the fact that Open Innovation is far from the dominant reference framework in Living Labs literature, we could find references to knowledge transfers between actors in all of the papers. As we considered this as one of the key characteristics of Open Innovation, we can conclude that Open Innovation is implicitly present witin Living Labs. Referring to the 'European Paradox', or the apparent gap between knowledge exploration and exploitation, at least in the literature there is also an imbalance in Living Labs. All of the Living Labs papers refer to knowledge exploration processes, whereas only one out of three papers mention exploitation processes. At least in terms of the Living Labs theory, there seems to be an issue with overcoming the European Paradox as there is too much focus on exploration.

Regarding User Innovation, 17 papers explicitly refer to this paradigm as theoretical foundation, but in all papers user involvement is a given which also shows that User Innovation is at least implicitly present in the Living Labs literature. Regarding the degree of user involvement, one of the key frameworks we identified in the User Innovation literature, 'design with users' is dominant in the majority of the papers, whereas 'design for users', or the classical 'voice-of-the-customers' techniques, is the main user involvement mode in 11 papers.

However, based on the literature, there is no general methodology towards user involvement in Living Labs, and the literature from the User Innovation paradigm is rarely extensively mentioned or implemented in the context of Living Labs. The Lead User concept pops up from time to time, but no clear method on how to implement this is provided. The only main

difference in user involvement approach between Living Labs was so-called open user involvement (self-selection) versus closed user involvement (selecting users with certain characteristics). The most clear definition sees Living Lab projects as a quasi-experimental approach with a 'pre' and a 'post' assessment of users with an intervention stage. This adheres to the three principles of Dell'Era and Landoni (2014), as this allows to capture the use context, the artifact can be seen as the intervention with the innovation or another stimulus (Proxy Technology Assessment, Prototype,…), and the user is actively involved in multiple stages (triangulization). **Our main conclusion is that in terms of methodology and user characteristics, the Living Labs literature is rather silent and positions Living Labs too much as an 'everything is possible' concept that resembles an empty box, in the sense that you can put whatever methodology or research approach inside.** It remains a given that users are involved in Living Labs, but although co-creation was said to be the central process in Living Labs (Levén & Holmström, 2012), 11 papers mentioned 'innovation for users' as the dominant interaction mode. For the 34 papers where 'innovation with users' is dominant, no clear co-creation methodology is put forward. Therefore, within the current Living Labs literature, it remains unclear whether Living Labs hold value in terms of structuring user involvement according to User Innovation theory.

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