A Review of Living Lab Research and Methods for User Involvement

Judy Hong Huang and Elisa Thomas

> *"Innovation is all about people. Innovation thrives when the population is diverse, accepting, and willing to cooperate."*
>
> Vivek Wadhwa
> Author and Entrepreneur

Living lab initiatives attempt to solve challenges by stimulating innovative collaboration and outcomes, which unfold in multifarious activities. This study investigates the progress of Living lab research over time. It explores its current trends, along with methods and tools used by Living labs for user involvement. By employing a two-step approach, the study first presents a bibliometric analysis of 535 publications, including detection of convergence towards areas like the aging problem of societies, smart cities, and overall sustainability. Urban Living lab clusters have been growing rapidly and forming their own research domain. Subsequently, a review of 42 empirical papers explores the methods and tools adopted by Living labs for user involvement during the innovation process. We categorize the methods into the following eight groups: 1) Structured interaction, 2) Flexible interaction, 3) Extended network, 4) Special actors, 5) Learning and engaging, 6) Design approaches; 7) Techniques, 8) Operational guidelines. The study contributes both to theoretical and practice-oriented Living lab research and offers potential support especially to practitioners.

Introduction

The notion of "living labs" has received growing attention in the realm of innovation management. Acting as one form of open innovation that brings external players into the innovation process (Chesbrough et al., 2006), a living lab provides a real-life milieu that stimulates innovative collaboration among people for solving challenges (Westerlund & Leminen, 2011; Almirall et al., 2012). The user-centric approach encourages active participation and integrates users' knowledge into the value creation process, thereby magnifying innovative competence (Eriksson et al., 2006; Leminen et al., 2012).

After over two decades of development, "living lab" is now a term associated with diverse meanings and research spread into multiple disciplines (Leminen & Westerlund, 2019). Earlier studies have touched upon numerous aspects such as definitions (Leminen et al., 2012), key principles and components (Bergvall-Kareborn & Stahlbrost, 2009; Westerlund et al., 2018a), users' roles (Leminen et al., 2015a), and users' motivation (Bergvall-Kareborn & Stahlbrost, 2009). One of the first living lab literature reviews from Følstad (2008) covered its theoretical foundations, processes, and methods in the Information Communication Technology (ICT) domain, highlighting contextual research and user co-creation as living labs' unique attributes. Later scholars contributed in drawing a broader picture. For instance, a trend analysis of research topics in living labs (Westerlund et al., 2018b), with a longitudinal review of the living lab movement showed early scattered activities, then the establishment of cross-regional and professional living labs (Leminen & Westerlund, 2019). Some scholars used big data

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techniques, like bibliometric analysis, or similar ones for mapping a living lab's landscape, thus adding a higher level of understanding such as its intellectual structure (McLoughlin et al., 2018; Greve et al., 2020).

Despite its rapid growth, research on this fairly young phenomenon remains dispersed (Greve et al., 2020). Studies are sparse in areas, applications, publication venues, etc., making it hard to grasp the latest situation. When it comes to user involvement, one unique characteristic of living labs (Bergvall-Kareborn & Stahlbrost, 2009) follows from having inadequate information about how living labs actually involve users (Puerari et al., 2018). Methods and details reflecting their user-centric character remain unclear (Schuurman et al., 2015). Scholars have not yet reached a consensus about models or guidance involving living lab governance and value creation for stakeholders (Westerlund et al., 2018a), which hinders the integration of studies at large. Measuring the effectiveness of user-centric approaches is another underexplored area (Ballon et al., 2018). Meanwhile, wide-ranging practices and methodologies get labelled as "living labs" (Leminen, 2015), making living lab methods and approaches sometimes into just vague words. Here arises the need for more practice-oriented living lab research, both for scholars and practitioners (Westerlund et al., 2018b). On that account, we decided to shed more light on the living lab phenomenon, and aim in this paper to answer the following questions: *i. How has living lab research advanced over time, and what are the current trends? ii. What are the methods and tools used by living labs for user involvement?*

We employ a two-step approach in this literature review. The first section presents a bibliometric analysis of 535 living lab studies from 1991 to 2021 on the topic of developing a consolidated understanding of its research development in terms of publication venues, contributing authors and their collaboration patterns, structures of research domains, and trends. By dividing the twenty years into two periods, we contrast and observe the change and shift of development patterns over time. In the second section, we contribute a further review of 42 empirical papers by identifying eight thematic domains of methods for user involvement in living labs from various aspects, including the format, technique, design approach, and overarching rules across different stages of the innovation process. We also summarize the tools for user involvement in these studies, in both physical and digital forms. Based on these findings and analyses, we discuss the implications and conclude with suggestions for future exploration.

Living Lab Research Development

The global "living lab movement", especially boosted by European living labs since the establishment of the European Network of Living labs (ENoLL) in 2006, has been drawing attention from researchers and policymakers over the last few years (Hossain et al., 2019; Leminen & Westerlund, 2019). Living lab meanings are manifold: a user-centric methodology (Eriksson et al., 2005), an approach for empowering users (Bergvall-Kareborn & Stahlbrost, 2009), an intermediary for collaboration (Almirall & Wareham, 2011), both the methodology and its structural instrument/agent for user collaboration activities (Almirall et al., 2012), an innovation system/approach/organization that monitors a living social experiment, or just the European living lab movement (Dutilleul et al., 2010).

While scholars differentiate living lab definitions and types, they seek also to establish some common understandings. Bergvall-Kareborn and Stahlbrost (2009) suggested considering the different focus of perspectives under varying circumstances and viewing living lab definitions as complementary. Leminen (2013) highlighted shared elements like "real-life", "user participation", and established "living lab approaches". Others also discuss multiple stakeholders and collaboration during the innovation process (Ballon et al., 2005; Bergvall-Kareborn & Stahlbrost, 2009; Westerlund & Leminen, 2011; Leminen, 2015). Here we refer to the definition by Westerlund and Leminen (2011) of living labs: "Physical regions or virtual realities, or interaction spaces, in which stakeholders from 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".

Living lab is notably associated with two mainstream research approaches to open innovation and user innovation (Almirall et al., 2012; Schuurman et al., 2015;

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Hossain et al., 2019). "Open innovation" is about firms opening up in the research and development process, while exchanging knowledge with external parties (Chesbrough, 2003). User innovation emphasizes the importance of users' heterogeneous needs and innovative abilities (von Hippel, 2005). Discussions of users in innovation trace back to the lead user theory and user-centric innovation, where users are highlighted as a vital source of innovation (von Hippel, 1988, 2005). Living labs, which embrace open innovation and user-centric concepts, provide a network and structured platform for innovative collaboration (Leminen et al., 2012).

Co-creation has also been emphasized as a salient feature of living labs with a locus of living lab experiences (Følstad, 2008; Leminen et al., 2012). We refer also therefore to this definition from Haukipuro et al. (2018) of living labs, which have a "way of working to develop new solutions together with users right from the early stages of development". Instead of merely being a testing object, users help to fill in blank spots between production and actual user needs (Steen & Van Bueren, 2017). Users as stakeholders actively participate in various forms of activities for exploring new ideas, creating and evaluating new solutions (Ballon et al., 2018). This high-quality knowledge exchange process stimulates the creation of values between firms and users (Prahalad & Ramaswamy, 2004). Such an open approach with progressive engagement have benefited firms by enabling relevant parties to actively contribute to innovation (Almirall & Casadesus-Masanell, 2010). Subsequently, it mitigates potential risks after market launch and leads to further improvement (Ballon & Schuurman, 2015; Schuurman et al., 2016).

Early studies answered "what" questions about living labs, but generally lacked conceptual and methodological knowledge (Bergvall-Kareborn & Stahlbrost, 2009; Leminen & Westerlund, 2017). Studies about methods and activities for co-creation were rather scant. Følstad (2008) listed a few methods for gathering data, such as analysing system logs or automatically collected behavioural data, ethnographic methods, questionnaires, focus groups, and generally, observation, arguing that there is no specific method catered for co-creation yet, instead just for stimulating its potential. Furthermore, Feurstein et al. (2008) summarized methods according to different innovation stages and grouped them into traditional methods and eCollaboration methods (aided by the Internet), so as to assist firms in choosing and developing suitable methods for user interactions.

The literature more recently is moving toward practice-oriented research about how to design and manage living labs, how to work with actors, and application contexts (Leminen et al., 2015b). Haukipuro et al. (2018) proposed a model of innovation instruments (how the work carries out) to facilitate a co-creation process, suggesting tailored methods for living labs to facilitate collaboration in various environments. Another longitudinal study from Hakkarainen and Hyysalo (2013) explained the intermediary roles of living labs, stating that their intermediation work is wide-ranging, beyond merely facilitation.

Despite an increasing amount of attention received about living labs, researchers point out the reality that users have not yet reached the proclaimed level of co-creation (Greve et al., 2017). Instead of playing active roles as expected, many users remain passive during the innovation process (Nyström et al., 2014), leaving much to explore about actualizing user involvement in living labs. Scholars argue there is no lack of methods and tools, but rather that their usage fails to demonstrate the unique characteristics of living labs, especially considering user involvement (Bergvall-Kareborn & Stahlbrost, 2009). Studies have also shown that the heterogeneity of methods used has made it hard to compare or adopt on a broader scale (Mulder, 2012). The diversity of methods that reside in living labs, their activities, channels of communication, and reporting have hindered the flow of knowledge exchange. Leminen and Westerlund (2017) developed a conceptual framework for understanding the relationship between innovation processes and tools. They argued that the various approaches would have different impacts on the innovation outcomes: the utilization of standardized tools and predefined innovation processes reduces the complicacy of innovation, whereas customized tools and iterative innovation processes promote radical innovation development.

Further investigation is needed to integrate knowledge about the methods and tools applied in living lab environments. We therefore continue the exploration

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here by screening and mapping studies from the field. We follow Merriam-Webster (2021a) which defines "method" as "a procedure or process for attaining an object" and "tool" as "a handheld device that aids in accomplishing a task or something" (Merriam-Webster, 2021b). We also take Følstad's (2008) concept of "methods" as "standardized procedures for data collection, evaluation or experimentation; typically included as elements in innovation and development processes".

Method

This study employed a two-step approach: a bibliometric analysis for an overall assessment of literature development, followed by a further review of methods and tools for user involvement in living labs based on empirical studies. To ensure the quality of performing this comprehensive bibliometric analysis, we followed the methods and workflow guidelines from Zupic and Čater (2015). Using data extracted from the first step, we continued with a thematic analysis on the full texts of 42 selected empirical papers on living labs. We adhered to evidence-based research methods (Tranfield et al., 2003) to ensure clarity and coverage in identifying, selecting, and evaluating data.

The research used two data sources, Web of Science (WoS) and Scopus. Both are commonly used bibliometric databases and have been recognized for their coverage of living lab research (McLoughlin et al., 2018). WoS is more selective on material indexing, while Scopus is more inclusive (Martín-Martín et al., 2018). Past bibliometric analysis studies on living labs chose different databases: Greve et al. (2021) and Greve et al. (2020) used WoS only, while McLoughlin et al. (2018) used Scopus, Google Scholar, and the AIS basket of eight (a term for the eight leading journals from the Association for Information Systems). Our assessment also confirms that WoS and Scopus have different coverage in terms of living lab publications: overlapping, but neither is inclusive (Burnham, 2006). WoS includes more, but not all living lab papers from The Technology Innovation Management Review (TIM Review), a journal that publishes the most living lab papers. Scopus also covers documents that WoS does not capture, for example, some from Sustainability. Taken overall, they complement each other. Thus, we combined both to get broader access to living lab literature.

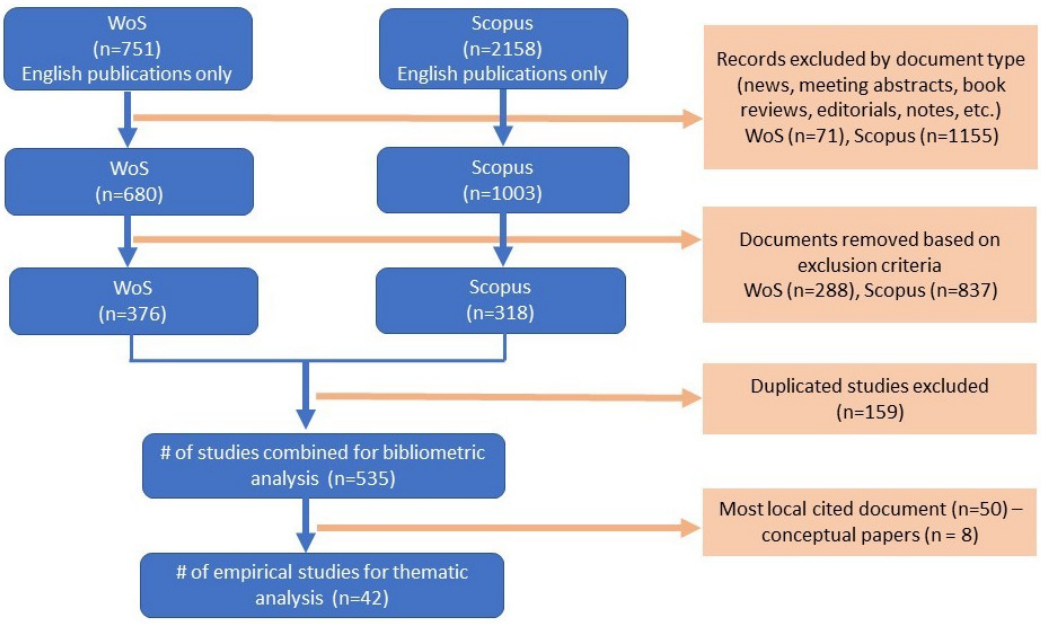

Figure 1. Methodological Approach

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We then developed the search string and restrictions by referring to several literature reviews on living labs (Schuurman et al., 2015; McLoughlin et al., 2018; Greve et al., 2020). They are: "living lab*" OR "livinglab" OR "living laborator*" that appears in the title, abstract, or author keywords of documents. The * sign was used to capture words in their plural forms. Publication types were restricted to peer-reviewed journal articles, books, and book chapters in English across all years. A search ran separately on WoS and Scopus web portals in January 2021, with 751 and 2,158 documents returned respectively. The exclusion criteria were: 1. Scientific-experiment labs analysing collected user data, but which did not involve users in the process, 2. Labs in the context of nature, living animals, ecology terms, not focused on human beings, 3. Metaphors for a region, country, or society only, and, 4. Living lab as an approach for solving certain social/experimental problems, but with no users involved.

The screening process took place on both portals (Figure 1), where the authors read the titles, keywords, abstracts, and even the content of the documents. The authors discussed and agreed on the search strings, exclusion criteria, and other issues related to paper selections. After the screening, there were 376 documents from WoS and 318 from Scopus. We downloaded the data and loaded it into the software RStudio installed with a bibliometrix package, which combined both and removed 159 duplicates. We then reached the final 535 documents, consisting of 474 journal articles, 5 books, and 56 book chapters. We ran this combined data file on Biblioshiny, a web-based interface of R-package for bibliometric analyses, following the bibliometric method: citation, co-citation, co-author, bibliographic coupling, and co-word (Aria & Cuccurullo, 2017). The analyses mapped intellectual streams and approaches, generating a visualization of patterns, distribution, domains, and trends.

Step two, the review started with a list of the most local cited documents from Biblioshiny, following the results from the co-citation analysis (when two units are both cited by a third unit). Biblioshiny can use as a unit of analysis the document, author, and journal (Aria & Cuccurullo, 2017). We took document co-citation since we were interested in reading the full text of these documents. These co-cited documents are listed based

Table 1. 20 most relevant sources

Source	*Type*	*No. of documents*
The Technology Innovation Management Review	Journal	43
Sustainability	Journal	30
Urban Living Labs: Experimenting with City Futures	Book	13
The Journal of Cleaner Production	Journal	10
Info: The journal of policy, regulation and strategy for telecommunications, information and media (Now: Digital Policy, Regulation and Governance)	Journal	7
Urban Planning	Journal	7
Innovation and Research in BioMedical engineering	Journal	6
International Journal of Sustainability in Higher Education	Journal	5
Living Labs: Design and Assessment of Sustainable Living	Book	5
ACM Transactions on Computer-Human Interaction	Journal	4

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on the number of citations received within the network. "Local" means within the sample collection, and "global" means the entire database collection (Aria & Cuccurullo, 2017). The global citation generally is a higher number, but tends to return documents from all disciplines, not necessarily living lab focused. Using citation as the selection criterion, which often appears in the format of "top-N" lists of units, helps detect the influencing works and common practices in the field (Zupic & Čater, 2015). McLoughlin et al. (2018) extracted the top 60 conceptual & methodological living lab papers based on citation count for their citation analysis, and Greve et al. (2020) performed co-citation analyses on the 41 most cited articles within its databases (297 articles). Overall, the local citation numbers of these 535 documents were much smaller than their global citation numbers, which can be explained by the diversity of documents within the collection. We shortlisted the 50 documents with the most local citations, and they turned out to be journal papers only; eight conceptual and 42 empirical. We performed a thematic analysis on the empirical papers, searching for words associated with method/methodology/tool, identifying and coding the relevant content based on definitions and contexts, grouping content by combining codes, and developing themes (Braun & Clarke, 2006; Clarke & Braun, 2017).

Findings

We start by presenting the findings from the bibliometric analysis. The 535 documents were published between January 1991 and January 2021. 80% are from 2015 onwards, which reflects the recently rapid growth of living lab research. They are from 324 sources: journals articles (474), books (5), and book chapters (56). Table 1 lists ten sources with the most publications, with TIM Review and Sustainability the two journals having the most living lab articles published. There were two books: one about Urban living labs (Marvin et al., 2018) and one about living labs for sustainable living (Keyson et al., 2017). A measurement by g-index, which measures a publication's global citation impact, wherein the top g articles receive a total of at least g2 citations (Egghe, 2006), shows that journals like TIM Review (16), Journal of Cleaner Production (10), Sustainability (8), and Digital Policy, Regulation, and Governance (7) are also the most influential journals for living lab research. It is worth noticing that there are fewer living labs papers published in other journals, or in journals with high rankings, referencing the Academic Journal Guide 2021 (Jena, 2021). The relatively limited quantity of publication outlets echoes prior findings that living lab studies remain in a small community of dissemination and authors in this field (McLoughlin et al., 2018; Greve et al., 2021).

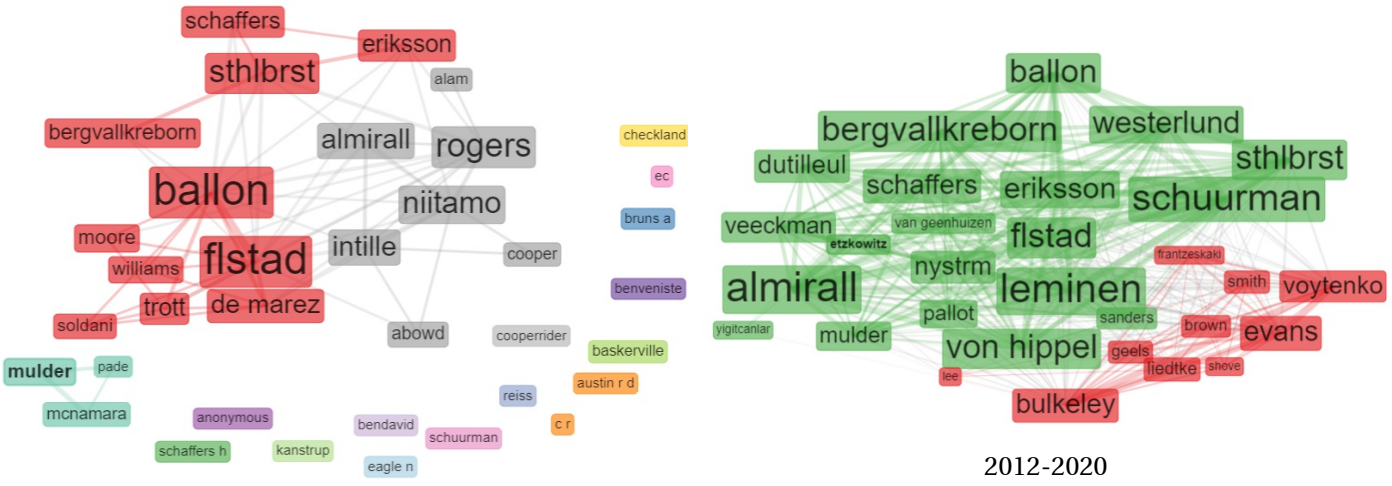

Figure 2. Co-citation of authors

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To have a better understanding of the growth in publication, we compare living lab studies by dividing the twenty years into two periods: 1991-2011 and 2011-2020. 2021 was excluded as the data were up to January 22 only. Figure 2 shows the results in terms of authors from a co-citation analysis, which is one popular method used for quantified evaluation involving the influence of works and interconnections among a network (Zupic & Čater, 2015). Mapping the co-citation patterns (relationships among the network) over some time also helps to detect the shift in research ideas and methods used (Small, 1973). When two authors are cited by a third one, a connection is established and a co-citation network is formed (Aria & Cuccurullo, 2017). The thickness of the lines represents the level of connection through publications. During 1991-2011, there were 25 scattered clusters with only a few key authors citing each other. Two main clusters formed during 2012-2020, with the larger one a continuous stream for living labs, and a new one focusing specifically on urban living labs, with researchers like James Evans, Harriet Bulkeley, and Yuliya Voytenko.

Figure 3 illustrates the results from a collaboration network analysis that measured co-authorships among authors (Zupic & Čater, 2015): the 41 clusters during 1991-2011 were divergent, with very few connected nodes, which means few collaboration groups among authors. The 16 clusters in 2012-2020 exhibit more convergence with several collaborative groups forming around a few key contributors, like Esteve Almirall, Seppo Leminen, and Dimitri Schuurman. There are many more, and different key authors in the recent period, suggesting a fast growth in a short time. Still, the sizes of these groups are relatively compact. The distribution is sparse with rather weak connections, along with long distances among groups, which reveals still immaturity of living lab research development, despite the growth of living lab researcher strength and collaboration.

To estimate the relationships and conceptual structures of the various research domains, we investigated the co-occurrence network, measured by the appearance of keywords (co-word) or other terms in the documents (Zupic & Čater, 2015). The period of 1991-2011 consisted of 23 diverse research domains clusters (Figure 4). Major themes like “innovation”, “living lab”, “information technology”, “open innovation”, “user-centric”, “approach”, indicate the founding topics during the early conceptual phase of living lab research. The rest are tiny and isolated clusters. The period 2012-2020 has three clusters: innovation, human, and living lab (about its design and concepts). The last two have gained more consensus, as in a more concise and interconnected form. The innovation cluster has wide-ranging sub-

1991-2011 2012-2020

Figure 3. Collaboration network

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topics from sectors like energy, education, urban, city/cities, to topics like governance, framework, and sustainability, with sustainability and smart city being the two most extensive and interconnected themes. This echoes with the suggestion from Hossain et al. (2019) that "sustainability" is often connected with the topic of "smart city", with the latter one providing the contextual settings. Interestingly, though "human" (as a subject) is one of the most frequently occurring keywords, "user", or "user innovation" that point to users' roles, are not among the most frequent terms, nor is "stakeholder". "Co-creation", "open innovation", and "methodology" (or "method") do not occur as frequently in the recent period, and tended to become outlying keywords in the newer living lab cluster. As for methods, this might be partly explained by the fact that they occur in their exact form, like workshops, focus groups, questionnaires, activities, etc., rather than as a topic at an integrative level.

By matching the year and frequency of keywords' occurrence, it shows the trending topics over time (Figure 5). In the last decade, living labs research has extended beyond the ICT domain to more diverse disciplines, with several evident topics like sustainability, smart city, urban, and ageing population. Though the smart city topic has been gaining attention for a while, its surge began in 2018. Similar topics like urban planning and urban development, sustainability and smart city, climate change, and transition emerge around each other. Topics related to the ageing population have clearly earned great emphasis in recent years.

To further explore, we ran a bibliographic coupling analysis, which examines the references shared by two documents (opposite to co-citation), checks the similarities, and depicts the latest research trend (Zupic & Čater, 2015; Aria & Cuccurullo, 2017). Figure 6 shows three main clusters during the period 2012-2020: Cluster 1, Technology Innovation (the "main school" of living lab research), along with two Urban Living lab clusters, Cluster 2 led by work from authors Voytenko et al. (2016), and Cluster 3 from work by Menny et al. (2018). The variety in urban living labs perhaps explains the existence of different working groups. We should note the heavily overlapping areas that suggest strong interconnections among studies. Clusters 2 & 3 are distant from Cluster 1, which implies that urban living lab research is probably growing out of the "main school" to form its own cluster(s). This aligns with our findings from co-citation and co-word analysis. The existence of several other less connected clusters also acknowledges multi-directional research development in the urban living lab domain.

We now focus on the review of 42 empirical articles for identifying methods and tools for user involvement. Among them, 15 papers were from the urban living labs field, making it the largest field. The rest were from areas: ICT (8), health (4), multiple - covering more than one field (6), others (9). Publication years range from

1991-2011

2012-2020

Figure 4. Co-occurrence network

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1991 to 2019: one is from 1991, and 41 are between 2010 and 2019. Following the definitions of "method" and "tool" from Merriam-Webster (2021a, 2021b) and Følstad (2008) above, we conducted coding and grouping, then subsequently identified eight thematic domains in terms of methods. We adopted the first two from Leminen et al. (2015b) and generated the rest through analysis. Table 2 summarizes the findings (with a full list of papers in Appendix 1):

1) Structured interaction: formalized activities,

2) Flexible interaction: encouraging more interactions and flexibility,

3) Extended network: reaching out to broader networks for awareness and contact,

4) Special actors: using active players to engage the rest of the population,

5) Learning and engaging: creating an inclusive environment,

6) Design approaches: systemic methodologies for designing activities,

7) Techniques: employing particular tasks or procedures from other fields,

8) Operational guidelines: overarching and underlying rules for facilitating user involvement.

Structured interaction and flexible interaction are the two dominant types in terms of frequency of mention. The former refers to more formal and organized in predefined formats, such as observation, survey, user testing, etc. Additionally, it includes self-reporting methods, with users participating less interactively, and information collected through mediums like diaries, sensors, and activity logs. Flexible interactions

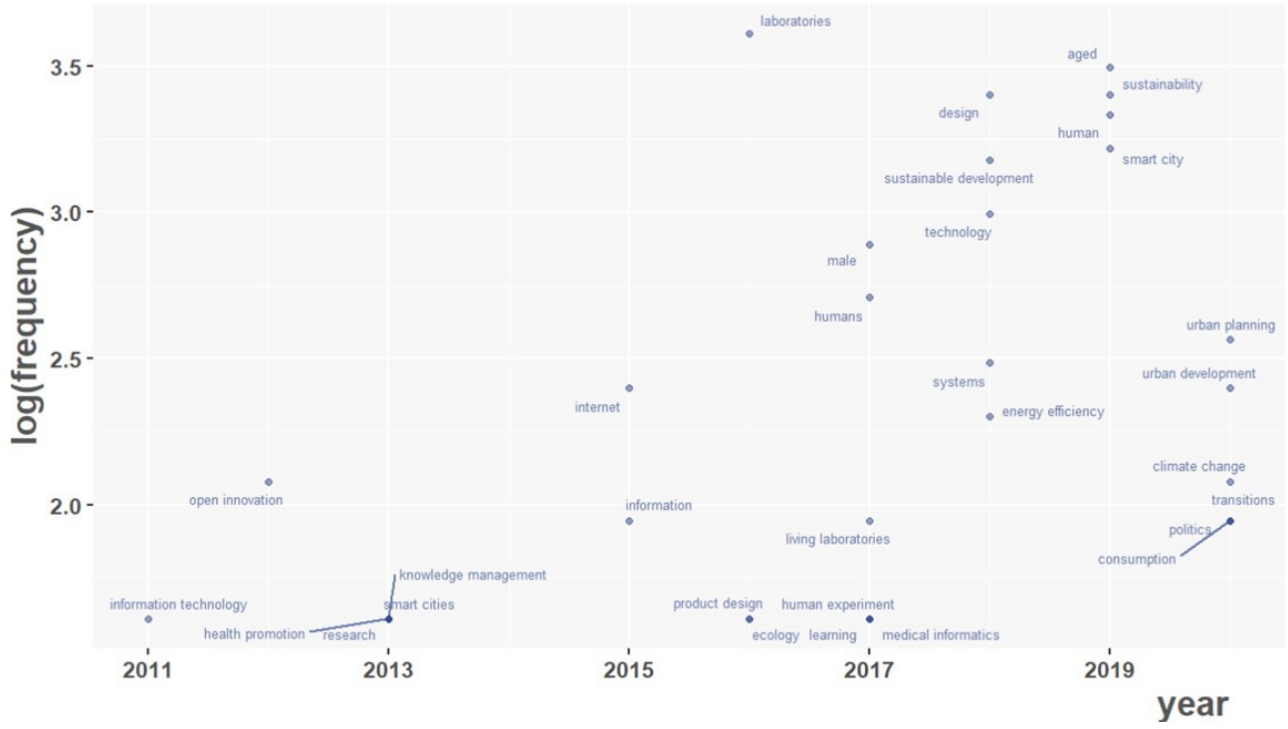

Figure 5. Trend topics

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tend to follow some guidelines, while having more freedom in arrangement and flexibility for interactions between organizers and participants, as well as among participants themselves. Among these flexible interaction methods, interviews, co-creation workshops, and user meetings are the most popular. The extended network highlights the importance of reaching out to a broad network through building or engaging active user communities, attracting public attention, and encouraging participation from users and related personnel. Having special actors echoes lead user theory by appointing active players as early movers and contact points among users. Learning and engaging investigates how to connect users in the process, mentioning methods like innovation camp, tailoring, team building, user training, and fun tasks that motivate users. Design approaches take more systematic design perspectives through participatory design, bottom-up approaches, design thinking, etc. Techniques involve using a few specific tasks or procedures that have certain formats and have been practiced in other fields, for example, storytelling, hackathons, round tables, World Café, etc. The last one, operational guidelines is more about general rules than specific methods. Aligning with the suggestions from Feurstein et al. (2008), we note one of the most mentioned guidelines is the multi-methodological approach that adopts differentiated methods at various stages of innovation for effective user involvement.

Table 3 summarizes the tools, which happen in both physical and digital formats. Digital tools like mobile applications and online platforms are the majority, while physical tools are less mentioned. Tools are used jointly with methods; thus, they are generally embedded in the methods section, rather than being a separate topic in these papers. They often come in packages such as websites, applications, and social media. There was much emphasis on methods and their applications in these papers. The tools should be examined along with their corresponding application method.

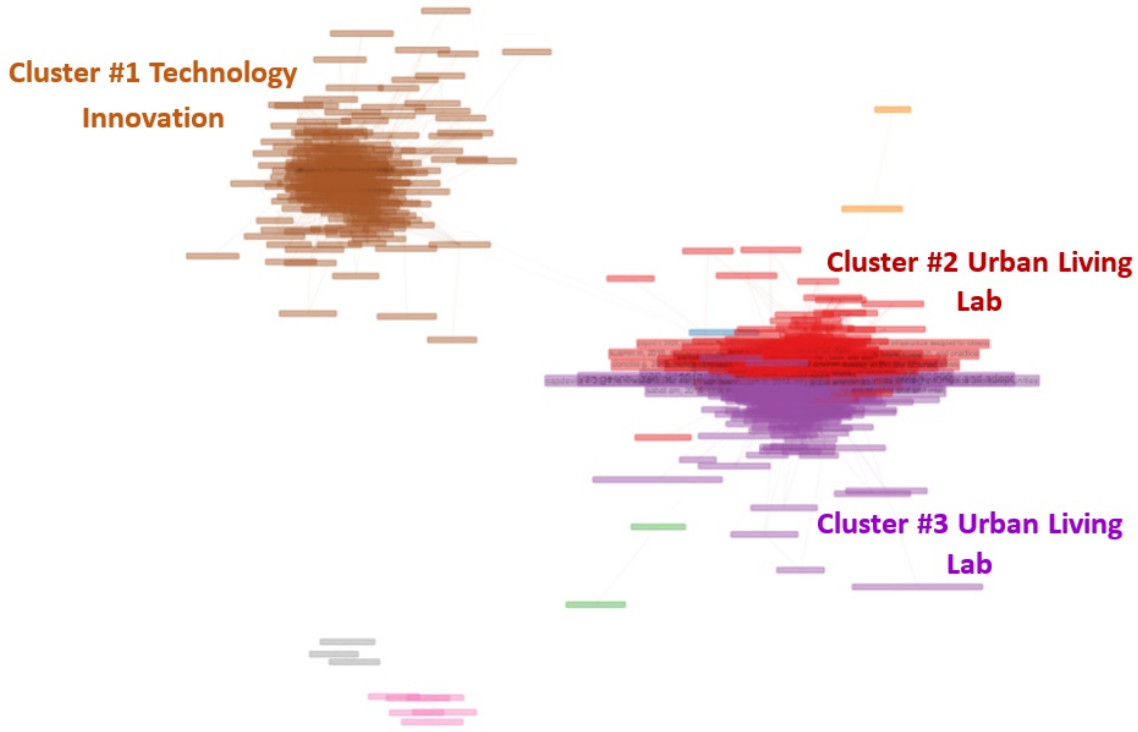

Figure 6. Bibliographic coupling clusters

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Table 2. Summary of methods used for user involvement in Living labs

Thematic Domain	Method	Further Information	Document*
Structured interaction	Observation	Contextual observation, in situ monitoring, participatory observation	7, 11, 13, 14, 15, 19, 26, 27, 29, 30, 36, 39, 47
	Survey		7, 11,15, 22, 27, 28, 30, 33, 45, 47
	Usability testing	Using prototypes or mock-ups to see if users can use the product	12, 36, 40, 43
	User testing	In a controlled environment or field trials; intervention during testing; long-term testing under realistic circumstance	7, 11, 12, 13, 14, 19, 23, 25, 26, 27, 29, 30, 36, 37, 39, 40, 43, 45, 50
	Self-reporting methods	diaries, sensors, logs	7, 11, 15, 19, 27, 29, 37, 39, 45
Flexible interaction	Interview, including focus group	Typically, in face-to-face format. (Note: interview can be a structured interaction too)	7, 9, 11, 14, 17, 26, 27, 30, 34, 36, 37, 40, 43, 45, 47
	Co-creation workshop	Fab lab is included here	7, 9, 11, 13,14, 18, 19, 22, 24, 26, 30, 31, 34, 36, 37, 39, 40, 45
	Co-joint analysis		40
	Follow-up visit		39
	Social/co-working space	Specially for long-term collaboration	37, 41
	User meeting	Discussion/sparring/ feedback	11, 13, 14, 22, 25, 45
	User experience field studies	Studying user experiences in their daily life contexts	27
Extended network	"Living room" for users	Activities that people in the community can join, such as parties	28
	Community workshop	An application of the formative invention method Change Laboratory	9
	Create/use local user community		9, 14, 17, 19, 29, 36, 47
	Inter-disciplinary groups		40
	Public awareness campaigns		11
	Broader network of participation	Extending to personnel related to users; extended geographical distance or disciplines	2,6, 11
Special actors	Ambassador		11
	Helpdesk or "repairer"	Accessible to users for assistance	12, 37
	Lead user		2, 36, 40
	Mediator	A single person that enlists participants	37
	Prime mover	A person who has strong interest in the project and acts as a contact person	37
Learning and engaging	Idea competition/campaign		11, 43
	Tailoring	Tailer-made approach for users at different skill levels	13
	Team building		14
	User training		13, 25
	"Having fun"	Including fun tasks that challenge users or trigger their curiosity	12, 22

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Table 2. Summary of methods used for user involvement in Living labs (cont'd)

Design approaches	Bottom-up approach	Informal; no imposed structure; support local champions	14
	Design thinking	Collecting some existing data and analysing it in a new way to develop innovative and flexible solutions	18
	Design-driven focus approach	Participants use the focal technology as they see fit without restrictions or prescriptions; allows open-ended insights into the context	44
	Participatory design	Also referred to as "co-design"	19, 30, 37, 41
	Practice-oriented design	Collaborative processes of discursive analysis and experimentation in daily life, shifting focus from products to practices	24
Techniques	Storytelling		18, 36, 40
	Hackathon		41
	Cultural probe		26
	MoSCoW method	For generating user stories: "Must Have, Should Have, Could Have, Won't Have this time"	43
	Round table		26
	Serious game simulation		26
	Virtual engagement/ community		6, 11, 40
	World Café	A conversational and interactive event (Brown & Isaacs, 2005)	45
Operational guidelines	Iterative approach	Iterative testing cycles for quick response and improvement	19, 22
	The "living" aspect	Sharing of development status and reflections; users can check the real-time information	9, 19
	Combined tools	Combining face-to-face methods and digital tools	45
	Communication	Clear and personal communication; clear feedback loop	12, 22
	Testing initiation process	Clear and straight forward testing initiation process	12
	Multi-methodological approach	Using differentiated methods at different stages of innovation	7, 11, 19, 23, 2, 30, 39, 40, 45
	Incentives	Providing incentives to encourage test users to complete tasks	12
	The benefits & co-creation aspect	Motivating users by letting them know that their contributions impact the innovation	12

* Documents are listed by their sequence numbers. See Appendix for the full list.

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Discussion and Conclusion

Our study analysed living lab research with an overview of its history and current trends. It presents a gap-filling summary of methods and tools employed for user involvement. Though living lab publications have increased rapidly in recent years, especially from 2015 onwards, it is still a new stream that is loosely connected with the leading publication channels in the field of innovation management. This limits the level of impact it could potentially make. Scholars like Greve et al. (2021) have mentioned the recent entry of living lab studies into some high-ranking publication outlets for innovation management studies, which could show some positive signs of progress. The living lab research network has transformed from only a few individuals and loosely allied groups, into several rising clusters. This is likely to stimulate the growth of the living labs research community and provide a basis for further studies.

Yet, meanwhile there is still no strong evidence for one or more dominant groups to act as a "core cluster network" (McLoughlin et al., 2018). The small-scale contributing scholars and collaborative clusters, with comparatively weak interconnections imply that living lab research is not yet full-grown. While living lab research topics are multi-disciplinary with various applications, they show some convergence on areas like the ageing population, smart cities, and sustainability. The last two are often interconnected and each associates with several sub-topics, thus confirming the earlier findings from McLoughlin et al. (2018) and Westerlund et al. (2018b).

There is a rising interest in urban living labs, which refers to "a form of collective urban governance and experimentation to address sustainability issues created by urbanization" (Veeckman & Temmerman, 2021). They share many characteristics with living labs, and focus on finding solutions for urban substantiality using a bottom-up approach with stakeholders that include citizens, public and private organizations, etc. (Juujärvi & Lund, 2016). Citizens are active users contributing through collaboration with other stakeholders and experts under the larger urban setting (Lehmann et al., 2015). "Urban living lab" has grown into an umbrella name for many similar activities, possibly due to the diversity within its domain. The research clusters show more divergence than the "main school" of living lab research, signalling that they are forming a distinctive research domain. Urban

Table 3. Tools used for user involvement

Tools	Documents*
Blog (community blog/user group blog)	14
Call/text message/chat/email	11, 18
Diary	11, 19, 27, 37, 45
Feedback form	40, 45
Feedback software (interactive technology)	39
Individual workbook	24
Mobile application	14,15, 19, 34, 37, 44, 45
Multi-media tool (video conferencing)	6, 9, 14, 45
Newsletter	22
Shared web portal for co-creation and/or reporting	11, 14, 17, 18, 22, 28, 34, 45
Postal service	14
Sensor toolkit (data logger)	7, 15, 29, 39
Service point (physical or remote)	18
Social media platform (e.g., Facebook, Twitter, Instagram)	6, 22, 28
Website	6, 19

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living lab researchers and practitioners are actively investigating and extracting methodologies for user involvement from the living lab research cluster (Steen & Van Bueren, 2017), while contributing back to the pool of living lab studies with knowledge gained from their thriving fields.

Meanwhile, a lack of solid endorsement for living lab's theoretical foundations remains, posing challenges to its integration into the mainstream innovation literature. Our study agrees with the need for more evident support to the conceptual roots and salient characteristics of living labs, such as co-creation or user-centric approaches (Schuurman et al., 2015). When moving toward practice-oriented research (Westerlund et al., 2018b), researchers should justify living lab concepts and approaches claimed in their empirical research. Importantly, a need for more well-rounded research is evident that bridges different perspectives of living lab methodologies to enable the sharing of empirical knowledge and accommodate researchers and practitioners in developing a more comprehensive understanding before drilling down to the practical level. This study answers the call for research on methods involving user involvement in living labs.

By drawing a list of methods and tools from some highly cited empirical papers, we hope to contribute to building an overall picture of the current and common approaches in facilitating co-creation, while touching upon various aspects such as the format, technique, systematic design approach, guidelines, etc. This is by no mean an exhaustive list, nor the invention of new methods, since popular ones like surveys, interviews, observation, workshops, and testing are already common in other fields. It is not about promoting certain standardized methods either because adoption or customization requires a deeper understanding of the methods and applicable circumstances. Co-creation is not a single-level activity, but rather a combination of multiple levels of user involvement (Menny et al., 2018), embedded in the design and implementation of living labs. This could be one entry point for further research and references for practitioners in complex practice areas. Having in-depth knowledge about the methods and tools could be beneficial for practitioners to assess, replicate, and improve living lab activities, while also assisting policymakers in making better decisions for fostering living labs and enhancing collaborations. Just as urban living labs have shown their notable contribution and potential in developing methods and tools for user involvement, the synthesis of a flourishing living lab with contributions from different disciplines has become essential.

Limitations and Future Research

This study analysed publications collected from two scholarly databases. Future research can consider expanding the research scope in terms of sources, document types, and volume. The selected empirical papers were only up to 2019, as it takes time for new ones to gain citations. Thus, using citation as the selection basis might have filtered out some recent publications or novel methods in the first place. Future studies should consider adopting different methods for paper selection. Meanwhile, many activities (including user collaborations) have shifted online since the pandemic began in 2020 (Westerlund et al., 2021). It would be interesting to review recent papers to investigate the shift in patterns and effectiveness regarding digital inclusion. Furthermore, these methods and tools are a means for actualizing the co-creation process. What matters more is to apply the suitable ones in their contextual settings, which could also be explored further.

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References

Almirall, E., & Casadesus-Masanell, R. 2010. Open Versus Closed Innovation: A model of discovery and divergence. *Academy of Management Review*, 35(1): 27-47. DOI: https://doi.org/10.5465/amr.35.1.zok27

Almirall, E., Lee, M., & Wareham, J. 2012. Mapping Living Labs in the Landscape of Innovation Methodologies. *Technology Innovation Management Review*, 2(9). DOI: http://doi.org/10.22215/timreview/603

Almirall, E., & Wareham, J. 2011. Living Labs: arbiters of mid-and ground-level innovation. *Technology Analysis & Strategic Management*, 23(1): 87-102. DOI: https://doi.org/10.1080/09537325.2011.537110

Aria, M., & Cuccurullo, C. 2017. Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4): 959-975. DOI: https://doi.org/10.1016/j.joi.2017.08.007

Ballon, P., Pierson, J., & Delaere, S. 2005. Test and Experimentation Platforms for Broadband Innovation: Examining European Practice. *SSRN Electronic Journal*. DOI: https://doi.org/10.2139/ssrn.1331557

Ballon, P., & Schuurman, D. 2015. Living Labs: concepts, tools and cases. *Info*, 17(4). DOI: https://doi.org/10.1108/info-04-2015-0024

Ballon, P., Van Hoed, M., & Schuurman, D. 2018. The Effectiveness of Involving Users in Digital Innovation: Measuring the impact of living labs. *Telematics and Informatics*, 35(5): 1201-1214. DOI: https://doi.org/10.1016/j.tele.2018.02.003

Bergvall-Kareborn, B., & Stahlbrost, A. 2009. Living Lab: an open and citizen-centric approach for innovation. *International Journal of Innovation and Regional Development*, 1(4): 356-370. DOI: http://doi.org/10.1504/IJIRD.2009.022727

Braun, V., & Clarke, V. 2006. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, 3(2): 77-101. DOI: https://doi.org/10.1191/1478088706qp063oa

Brown, J., & Isaacs, D. 2005. *The World Café: Shaping Our Futures Through Conversations That Matter*. San Francisco, CA: Berrett-Koehler Publishers.

Burnham, J.F. 2006. Scopus Database: a review. *Biomedical Digital Libraries*, 3(1): 1. DOI: https://doi.org/10.1186/1742-5581-3-1

Chesbrough, H. 2003. The Era of Open Innovation. *MIT Sloan Management Review*, 44: 35-41. DOI: https://sloanreview.mit.edu/article/the-era-of-open-innovation/

Chesbrough, H., Vanhaverbeke, W., & West, J. 2006. *Open Innovation: researching a new paradigm*. Oxford: Oxford University Press.

Clarke, V., & Braun, V. 2017. Thematic Analysis. *The Journal of Positive Psychology*, 12(3): 297-298. DOI: https://doi.org/10.1080/17439760.2016.1262613

Dutilleul, B., Birrer, F.A.J., & Mensink, W. 2010. Unpacking European Living Labs: Analysing Innovation's Social Dimensions. *Central European Journal of Public Policy*, 4(1): 60-85. DOI: https://ssrn.com/abstract=2533251

Egghe, L. 2006. Theory and Practise of the G-index. Scientometrics, 69(1): 131-152. DOI: https://doi.org/10.1007/s11192-006-0144-7

Eriksson, M., Niitamo, V.P., & Kulkki, S. 2005. *State-of-the-art in Utilizing Living Labs Approach to User-Centric ICT Innovation - a European approach*. Lulea: Center for Distance-spanning Technology. Lulea University of Technology Sweden: Lulea, DOI: http://84.88.32.6/openlivinglabs/documents/SOA_LivingLabs.pdf

Eriksson, M., Niitamo, V.P., Kulkki, S., & Hribernik, K. 2006. Living Labs as a Multi-Contextual R&D methodology. *The 12th International Conference ldots*. DOI: https://doi.org/10.1109/ICE.2006.7477082

Feurstein, K., Hesmer, A., Hribernik, K.A., Thoben, K., & Schumacher, J. 2008. Living Labs: a new development strategy. *European Living Labs-a new approach for human centric regional innovation*: 1-14.

Følstad, A. 2008. Living Labs for Innovation and Development of Information and Communication Technology: A Literature Review. *The Electronic Journal for Virtual Organizations and Networks*, 10: 99-129. DOI: http://hdl.handle.net/11250/2440026

Greve, K., De Vita, R., Leminen, S., & Westerlund, M. 2021. Living Labs: From Niche to Mainstream Innovation Management. *Sustainability*, 13: 791. DOI: https://doi.org/10.3390/su13020791

Greve, K., Leminen, S., Vita, R., & Westerlund, M. 2020. Unveiling the Diversity of Scholarly Debate on Living Labs: A bibliometric approach. *International Journal of Innovation Management*. DOI: https://doi.org/10.1142/S1363919620400034

Greve, K., Martinez, V., & Neely, A. 2017. *Bridging the Co-creation Gap Between Co-creators, Companies and Living Lab.*

Hakkarainen, L., & Hyysalo, S. 2013. How do we keep the Living Laboratory Alive? Learning and Conflicts in Living Lab Collaboration. *Technology Innovation Management Review*, 3(12): 45-58. DOI: http://doi.org/10.22215/timreview/749

Haukipuro, L., Väinämö, S., & Hyrkäs, P. 2018. Innovation Instruments to Co-Create Needs-Based Solutions in a Living Lab. *Technology Innovation*

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Management Review, 8(5): 22-35. DOI: http://doi.org/10.22215/timreview/1156

Hossain, M., Leminen, S., & Westerlund, M. 2019. A Systematic Review of Living Lab Literature. *Journal of Cleaner Production*, 213: 976-988. DOI: https://doi.org/10.1016/j.jclepro.2018.12.257

Jena, S. 2021. *Academic Journal Guide 2021 Ranking list*. https://charteredabs.org/academic-journal-guide-2021-view/

Juujärvi, S., & Lund, V. 2016. Enhancing Early Innovation in an Urban Living Lab: Lessons from Espoo, Finland. *Technology Innovation Management Review*, 6(1): 17-26. DOI: http://doi.org/10.22215/timreview/957

Keyson, D.V., Guerra-Santin, O., & Lockton, D. 2017. *Living Labs: Design and Assessment of Sustainable Living*.

Lehmann, V., Frangioni, M., & Dubé, P. 2015. Living Lab as Knowledge System: an actual approach for managing urban service projects? *Journal of Knowledge Management*, 19(5): 1087-1107. DOI: https://doi.org/10.1108/JKM-02-2015-0058

Leminen, S. 2013. Coordination and Participation in Living Lab Networks. *Technology Innovation Management Review*, 3(11). DOI: http://doi.org/10.22215/timreview/740

Leminen, S. 2015. Q&A. What Are Living Labs? *Technology Innovation Management Review*, 5(9). DOI: http://doi.org/10.22215/timreview/928

Leminen, S., Nyström, A.G., & Westerlund, M. 2015a. A Typology of Creative Consumers in Living Labs. *Journal of Engineering and Technology Management*, 37: 6-20. DOI: https://doi.org/10.1016/j.jengtecman.2015.08.008

Leminen, S., Turunen, T., & Westerlund, M. 2015b. The Grey Areas Between Open and Closed in Innovation Networks. *Technology Innovation Management Review*, 5(12): 6-18. DOI: http://doi.org/10.22215/timreview/948

Leminen, S., & Westerlund, M. 2017. Categorization of Innovation Tools in Living Labs. *Technology Innovation Management Review*, 7(1): 15-25. DOI: http://doi.org/10.22215/timreview/1046

Leminen, S., & Westerlund, M. 2019. Living Labs: From scattered initiatives to a global movement. *Creativity and Innovation Management*, 28(9). DOI: http://doi.org/10.1111/caim.12310

Leminen, S., Westerlund, M., & Nyström, A.G. 2012. Living Labs as Open-Innovation Networks. *Technology Innovation Management Review*, 2: 6-11. DOI: http://doi.org/10.22215/timreview/602

Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado López-Cózar, E. 2018. Google Scholar, Web of Science, and Scopus: A Systematic Comparison of Citations in 252 Subject Categories. *Journal of Informetrics*, 12(4): 1160-1177. DOI: https://doi.org/10.1016/j.joi.2018.09.002

Marvin, S., Bulkeley, H., Mai, L., McCormick, K., & Palgan, Y.V. 2018. *Urban living labs: Experimenting with city futures*. Routledge.

McLoughlin, S., Maccani, G., Prendergast, D., & Donnellan, B. 2018. Living Labs: A Bibliometric Analysis. *51st Hawaii International Conference on System Sciences*. DOI: https://doi.org/10.24251/hicss.2018.563

Menny, M., Palgan, Y.V., & McCormick, K. 2018. Urban Living Labs and the Role of Users in Co-Creation. *GAIA-Ecological Perspectives for Science and Society*, 27(1): 68-77. DOI: https://doi.org/10.14512/gaia.27.S1.14

Merriam-Webster. 2021a. Method. *Merriam-Webster.com dictionary*, DOI: https://www.merriam-webster.com/dictionary/method

Merriam-Webster. 2021b. Tool. *Merriam-Webster.com dictionary*, https://www.merriam-webster.com/dictionary/tool

Mulder, I. 2012. Living Labbing the Rotterdam Way: Co-creation as an enabler for urban innovation. *Technology Innovation Management Review*, 2(9). DOI: http://doi.org/10.22215/timreview/607

Nyström, A.G., Leminen, S., Westerlund, M., & Kortelainen, M. 2014. Actor Roles and Role Patterns Influencing Innovation in Living Labs. *Industrial Marketing Management*, 43(3): 483-495. DOI: https://doi.org/10.1016/j.indmarman.2013.12.016

Prahalad, C.K., & Ramaswamy, V. 2004. Co-Creation Experiences: The next practice in value creation. *Journal of Interactive Marketing*, 18(3): 5-14. DOI: https://doi.org/10.1002/dir.20015

Puerari, E., De Koning, J.I., Von Wirth, T., Karré, P.M., Mulder, I.J., & Loorbach, D.A. 2018. Co-Creation Dynamics in Urban Living Labs. *Sustainability*, 10(6): 1893. DOI: https://doi.org/10.3390/su10061893

Schuurman, D., De Marez, L., & Ballon, P. 2015. Living Labs: a systematic literature review. Paper presented at the *Open Living Lab Days 2015*, DOI: http://hdl.handle.net/1854/LU-7026155

Schuurman, D., De Marez, L., & Ballon, P. 2016. The Impact of Living Lab Methodology on Open Innovation Contributions and Outcomes. *Technology Innovation Management Review*, 6(1): 7-16. DOI: http://doi.org/10.22215/timreview/956

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Small, H. 1973. Co-Citation in the Scientific Literature: A New Measure of the Relationship Between Two Documents. *Journal of the American Society for Information Science*, 24: 265-269. DOI: https://doi.org/10.1002/asi.4630240406

Steen, K., & Van Bueren, E. 2017. The Defining Characteristics of Urban Living Labs. *Technology Innovation Management Review*, 7(7): 21-33. DOI: http://doi.org/10.22215/timreview/1088

Tranfield, D., Denyer, D., & Smart, P. 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. British Journal of management, 14(3): 207-222. DOI: https://doi.org/10.1111/1467-8551.00375

Veeckman, C., & Temmerman, L. 2021. Urban Living Labs and Citizen Science: From Innovation and Science towards Policy Impacts. Sustainability, 13: 526. DOI: https://doi.org/10.3390/su13020526

von Hippel, E. 1988. The sources of innovation. Oxford: Oxford University Press.

von Hippel, E. 2005. Democratizing Innovation: The evolving phenomenon of user innovation. Journal für Betriebswirtschaft, 55(1): 63-78. DOI: https://doi.org/10.1007/s11301-004-0002-8

Voytenko, Y., McCormick, K., Evans, J., & Schliwa, G. 2016. Urban living Labs for Sustainability and Low Carbon Cities in Europe: Towards a research agenda. Journal of cleaner production, 123: 45-54. DOI: https://doi.org/10.1016/j.jclepro.2015.08.053

Westerlund, M., Isabelle, D.A., & Leminen, S. 2021. The Acceptance of Digital Surveillance in an Age of Big Data. Technology Innovation Management Review, 11(3). DOI: http://doi.org/10.22215/timreview/1427

Westerlund, M., & Leminen, S. 2011. Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs. Technology Innovation Management Review, 1(1). DOI: http://doi.org/10.22215/timreview/489

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

Westerlund, M., Leminen, S., & Rajahonka, M. 2018b. A Topic Modelling Analysis of Living Labs Research. Technology innovation management review, 8(7): 40-51. DOI: http://doi.org/10.22215/timreview/1170

Zupic, I., & Čater, T. 2015. Bibliometric Methods in Management and Organization. Organizational Research Methods, 18(3): 429-472. DOI: https://doi.org/10.1177/1094428114562629

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Elisa Thomas is an Associate Professor at Nord University (Norway) and an Adjunct Associate Professor at the University of Stavanger (Norway). She is a leader of the Academic Division in Competences, Behaviour, and Culture for Innovation at the Brazilian Academy of Management (ANPAD), and a leader of the Special Interest Group on Responsible Innovation at the International Society for Professional Innovation Management (ISPIM). Her research interests include entrepreneurship and innovation ecosystems, the role of universities in regional development, start-up incubators, technology parks, and open innovation intermediaries.

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Appendix 1. List of most local cited papers

S/N	*Paper*
1	Almirall, E. & Wareham, J. 2011. Living Labs: arbiters of mid-and ground-level innovation. ***Technology Analysis & Strategic Management***, 23(1): 87-102.
2	Schuurman, D., De Marez, L., & Ballon, P. 2016. The impact of living lab methodology on open innovation contributions and outcomes. ***Technology Innovation Management Review***, 6(1): 7-16.
3	Leminen, S. & Westerlund, M. 2017. Categorization of Innovation Tools in Living Labs. ***Technology Innovation Management Review***, 7(1): 15-25.
4	Evans, J., Jones, R., Karvonen, A., Millard, L., & Wendler, J. 2015. Living labs and co-production: university campuses as platforms for sustainability science. ***Current Opinion in Environmental Sustainability***, 16: 1-6**.**
5	Liedtke, C., Baedeker, C., Hasselkuß, M., Rohn, H., & Grinewitschus, V. 2015. User-integrated innovation in Sustainable LivingLabs: an experimental infrastructure for researching and developing sustainable product service systems. ***Journal of Cleaner Production***, 97: 106-116.
6	Rits, O., Schuurman, D., & Ballon, P. 2015. Exploring the Benefits of Integrating Business Model Research within Living Lab Projects. ***Technology Innovation Management Review***, 5(12): 19-27.
7	Juujärvi, S. & Lund, V. 2016. Enhancing Early Innovation in an Urban Living Lab: Lessons from Espoo, Finland. ***Technology Innovation Management Review***, 6(1):17-26.
8	Steen, K. & Van Bueren, E., 2017. The defining characteristics of urban living labs. ***Technology Innovation Management Review***, 7(7): 21-33.
9	Menny, M., Palgan, Y.V. & McCormick, K., 2018. Urban living labs and the role of users in co-creation. ***GAIA-Ecological Perspectives for Science and Society***, 27(1): 68-77.
10	Georges, A., Schuurman, D. & Vervoort, K., 2016. Factors affecting the attrition of test users during living lab field trials. ***Technology Innovation Management Review***, 6(1): 35-44.
11	Hakkarainen, L. & Hyysalo, S., 2016. The evolution of intermediary activities: Broadening the concept of facilitation in living labs. ***Technology Innovation Management Review***, 6(1): 45-58.
12	Budweg, S., Schaffers, H., Ruland, R., Kristensen, K. & Prinz, W., 2011. Enhancing collaboration in communities of professionals using a Living Lab approach. ***Production Planning & Control***, 22(5-6): 594-609.
13	Cardone, G., Cirri, A., Corradi, A. & Foschini, L., 2014. The participact mobile crowd sensing living lab: The testbed for smart cities. ***IEEE Communications Magazine***, 52(10): 78-85.

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Appendix 1. List of most local cited papers (cont'd)

14	Bergvall-Kareborn, B. & Stahlbrost, A., 2009. Living Lab: an open and citizen-centric approach for innovation. ***International Journal of Innovation and Regional Development***, 1(4): 356-370.
15	Tukiainen, T., Leminen, S. & Westerlund, M., 2015. Cities as collaborative innovation platforms. ***Technology Innovation Management Review***, 5(10): 16-23.
16	Veeckman, C. & Van Der Graaf, S., 2015. The city as living laboratory: Empowering citizens with the citadel toolkit. ***Technology Innovation Management Review***, 5(3): 6-17.
17	Leminen, S., Nyström, A.G., Westerlund, M. & Kortelainen, M.J., 2016. The effect of network structure on radical innovation in living labs***. Journal of Business & Industrial Marketing,*** 31 (6): 743-757.
18	Logghe, S. & Schuurman, D. 2017. Action Research as a Framework to Evaluate the Operations of a Living Lab. ***Technology Innovation Management Review***, 7(2): 35-41.
19	Schäpke, N., Stelzer, F., Caniglia, G., Bergmann, M., Wanner, M., Singer-Brodowski, M., Loorbach, D., Olsson, P., Baedeker, C. & Lang, D.J., 2018. Jointly experimenting for transformation? Shaping real-world laboratories by comparing them. ***GAIA-Ecological Perspectives for Science and Society***, 27(1): 85-96.
20	Scott, K., Bakker, C. & Quist, J., 2012. Designing change by living change***. Design studies***, 33(3): 279-297.
21	Hyysalo, S. & Hakkarainen, L., 2014. What difference does a living lab make? Comparing two health technology innovation projects. ***CoDesign***, 10(3-4): 191-208.
22	Lehmann, V., Frangioni, M., & Dubé, P. 2015. Living Lab as knowledge system: an actual approach for managing urban service projects? ***Journal of Knowledge Management***, 19(5): 1087-1107.
23	Leminen, S., Turunen, T. & Westerlund, M., 2015. The grey areas between open and closed in innovation networks. ***Technology Innovation Management Review***, 5(12): 6-18
24	Buhr, K., Federley, M. & Karlsson, A., 2016. Urban living labs for sustainability in suburbs in need of modernization and social uplift. ***Technology Innovation Management Review***, 6(1): 27-34.
25	Claude, S., Ginestet, S., Bonhomme, M., Moulène, N. & Escadeillas, G., 2017. The Living Lab methodology for complex environments: Insights from the thermal refurbishment of a historical district in the city of Cahors, France. ***Energy research & social science***, 32: 121-130.
26	Coorevits, L. & Jacobs, A., 2017. Taking real-life seriously: an approach to decomposing context beyond 'environment' in living labs. ***Technology Innovation Management Review***, 7(1): 26-36.
27	Amenta, L. & Van Timmeren, A., 2018. Beyond wastescapes: Towards circular landscapes. Addressing the spatial dimension of circularity through the regeneration of wastescapes. ***Sustainability***, 10(12): 4740.
28	Bajgier, S.M., Maragah, H.D., Saccucci, M.S., Verzilli, A. & Prybutok, V.R., 1991. Introducing students to community operations research by using a city neighborhood as a living laboratory. ***Operations research***, 39(5): 701-709.

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Appendix 1. List of most local cited papers (cont'd)

29	Kanstrup, A.M., Bjerge, K. & Kristensen, J.E., 2010. A living laboratory exploring mobile support for everyday life with diabetes. ***Wireless personal communications***, 53(3): 395-408.
30	García-Guzmán, J., del Carpio, A.F., De Amescua, A. & Velasco, M., 2013. A process reference model for managing living labs for ICT innovation: A proposal based on ISO/IEC 15504. ***Computer Standards & Interfaces***, 36(1): 33-41.
31	Ley, B., Ogonowski, C., Mu, M., Hess, J., Race, N., Randall, D., Rouncefield, M. & Wulf, V., 2015. At home with users: A comparative view of living labs. ***Interacting with Computers***, 27(1): 21-35.
32	Schwartz, T., Stevens, G., Jakobi, T., Denef, S., Ramirez, L., Wulf, V. & Randall, D., 2015. What people do with consumption feedback: a long-term living lab study of a home energy management system. ***Interacting with Computers***, 27(6): 551-576.
33	Callaghan, R. & Herselman, M., 2015. Applying a Living Lab methodology to support innovation in education at a university in South Africa. ***The Journal for Transdisciplinary Research in Southern Africa***, 11(1): 21-38.
34	Leminen, S., Rajahonka, M. & Westerlund, M., 2017. Towards third-generation living lab networks in cities. ***Technology Innovation Management Review***, 7(11): 21-35.
35	Canzler, W., Engels, F., Rogge, J.C., Simon, D. & Wentland, A., 2017. From "living lab" to strategic action field: Bringing together energy, mobility, and Information Technology in Germany. ***Energy research & social science***, 27: 25-35.
36	Coenen, T. & Robijt, S., 2017. Heading for a FALL: A Framework for Agile Living Lab Projects. ***Technology Innovation Management Review***, 7(1): 27-43.
37	Brankaert, R. & den Ouden, E., 2017. The design-driven living lab: a new approach to exploring solutions to complex societal challenges. ***Technology Innovation Management Review***, 7(1): 44-51.
38	Haukipuro, L., Väinämö, S. & Hyrkäs, P., 2018. Innovation Instruments to Co-Create Needs-Based Solutions in a Living Lab. ***Technology Innovation Management Review***, 8(5): 22-35.
39	Pade-Khene, C., Palmer, R. & Kavhai, M., 2010. A baseline study of a Dwesa rural community for the Siyakhula Information and Communication Technology for Development project: understanding the reality on the ground. ***Information Development***, 26(4): 265-288.
40	Lepik, K.L., Krigul, M. & Terk, E., 2010. Introducing Living Lab's Method as Knowledge Transfer from One Socio-Institutional Context to Another: Evidence from Helsinki-Tallinn Cross-Border Region. ***Journal of Universal Computer Science***, 16(8): 1089-1101.
41	Hielkema, H. & Hongisto, P., 2013. Developing the Helsinki smart city: The role of competitions for open data applications. ***Journal of the Knowledge Economy***, 4(2): 190-204.
42	Karin, W., Annika, Å. & Anna, S., 2015. Exploring differences between central located test and home use test in a living lab context. ***International Journal of Consumer Studies***, 39(3): 230-238.