World of Living Labs

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Contents

Executive Summary

The Living Lab (LL) approach is a wide-ranging field which cannot be explained without certain aspects. This report therefore gives an overview on LL and of what they consist of. It should help the reader in understanding the origins, framework and specifics as well as how to organize and what to take care of in setting up a LL. This report can be seen as a compact document where to find the so called "Frequently Asked Questions" about the approach and certain examples on successful labs all around the world.

The first chapter gives an introduction on how a LL differentiates from other approaches and why LL can be seen as a milieu as well as a methodology. This way it will be made sure that author and reader start on the same page of the framework of a LL. For deepening the knowledge, the history of LL is described in the second chapter with several examples and to round things off a final definition amongst others and key elements are identified in chapter 3 and 4. Altogether, this first part describes the basics of a LL in a theoretical way to provide the reader with a solid reference guide on the essentials of this approach.

Based on this, concrete action steps are described to get an idea on how a LL can be implemented in a real-life setting. A crucial part is the involvement of actors and stakeholders as they are the main part of a LL (chapter 5). Different scientific approaches explain how to identify stakeholders to be part of a lab and what their roles are or should be. In the process of a LL various methods have to be used to reach the aims and objectives. In chapter 6, different methods are described in theory and it is explained what needs to be in place for their application. Different methods are then described in detail and summarized in additional fact boxes to see instantly for which setting the method is suitable. For a deeper understanding on how LL are handled in the field, national and international examples are described in chapter 6 and give an overview on the variety of LL, individual methods used and outcomes.

This report aims to accompany the reader in understanding the world of LL and to provide specific suggestions on how to organize a LL. LL are very dependent on their environment and therefore need to be treated individually. For this case the report is built up to give an overview of the different possibilities and still provides detailed information to enhance the knowledge about LL.

1. A short introduction to Living Labs: Essentials for making Living Labs 'living'

Living-Labs (LL) provide a specific setting in which new solutions to existing challenges can be developed in a real-life context. The "living" in Living Labs is defined by collaborative, co-creative, open research and innovation that applies similar tools and processes in different fields and domains. Furthermore, LL enable the involved stakeholders to understand, which innovations are successful in what context and why.

With the help of LL, solutions for user-centred problems are specifically developed with the users themselves. The consideration and integration of user needs in the research and development process favours a higher acceptance and a considerably higher market success of the products and services developed therein.

Although LL are strongly user-oriented, they are implemented in a scientific framework. However, local knowledge and knowledge from practitioners and users are met on an equal footing. LL offer an experimental set-up integrating a significant number of diverse stakeholders in a real-life environment. The goal is to co-develop socio-economic-technical transformation solutions to foster the learning and managing of local and user knowledge as a valuable complementary to the scientific knowledge.

LL can be seen from mainly two perspectives:

1. Living Lab as a milieu or research environment
2. Living Lab as a methodology, an innovation approach

Both perspectives are not contradictory, it is only a different way how to look at a LL.

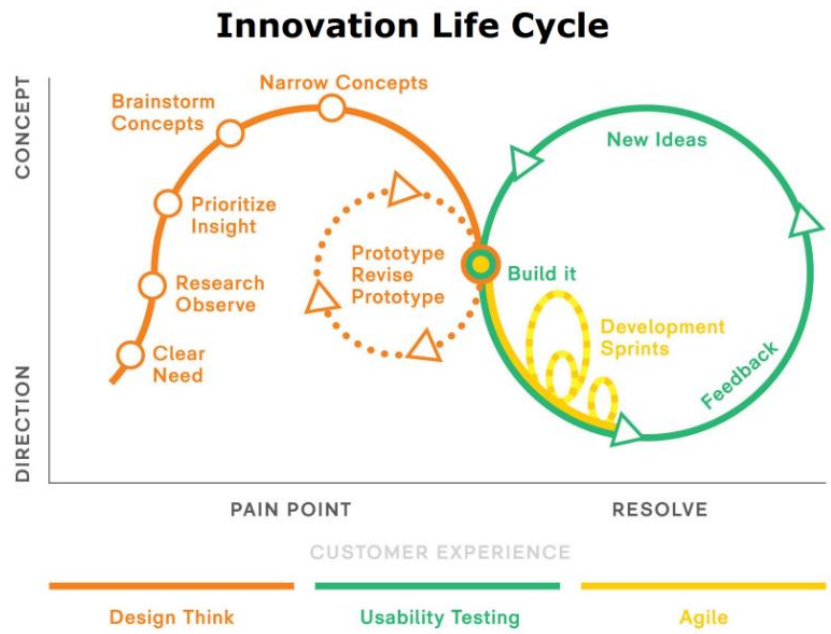


Figure 1: Integration of customer experience in open innovation process (Institute for innovation + improvement, 2020)

If a LL is understood as a methodology or innovation approach, then it is close to open innovation processes. However, nuances matter when differentiating between true LL and innovation networks, communities or clusters. LL are innovation networks based on the philosophy of open innovation, but – and this is key - where users become equivalent to other participants. Within LL, users shape the innovation in their daily real-life environments, whereas in traditional innovation networks or labs, the usability of a prototype is tested, customers experience is observed, and the users' insights are captured and interpreted by experts (see Figure 1).

An even more comprehensive perspective on LL is the understanding of it as a milieu or research environment. LL offer an environment, a niche where new ideas and innovations can take place, be tested and further developed in an experimental way. LL provide a "protected" space ("niche") where innovation can grow stronger for overcoming the barriers of the existing regime.

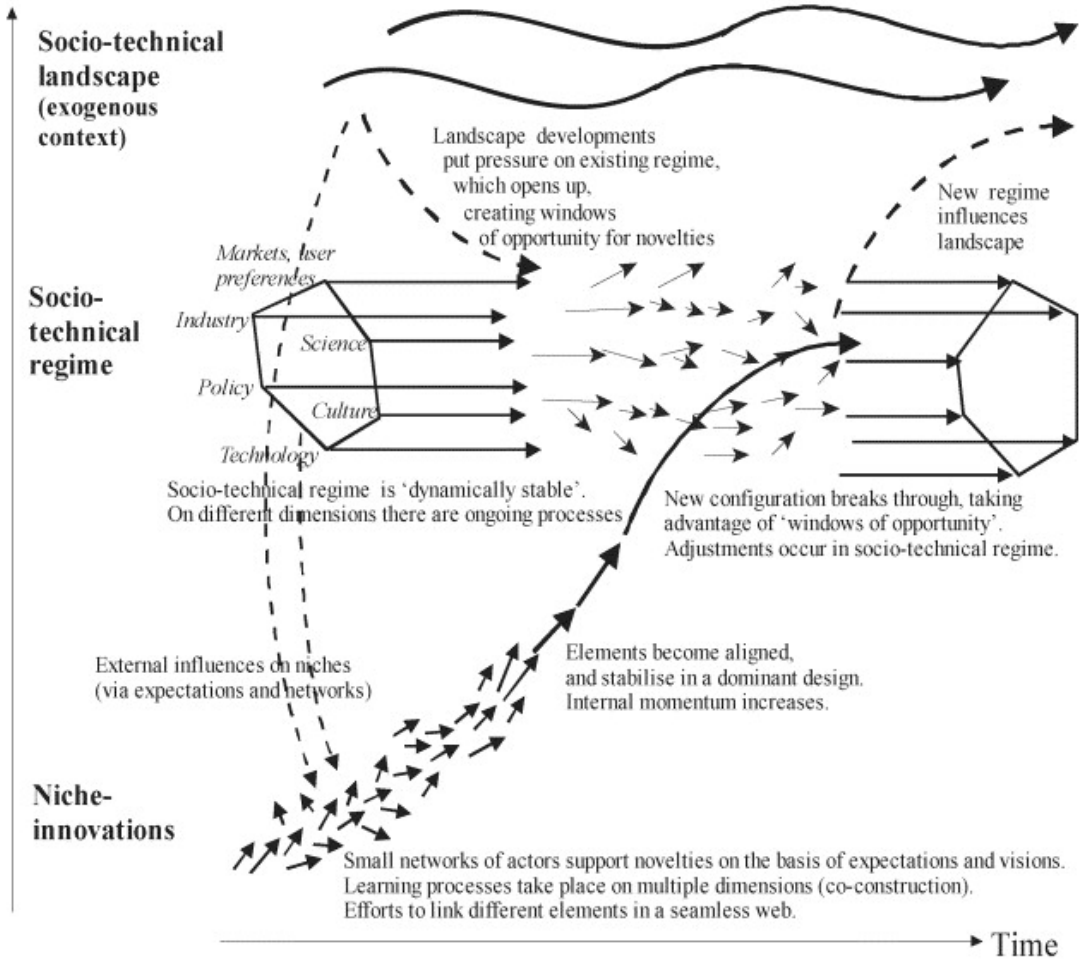


Figure 2: Multi-level perspective on (technological) transitions (Geels and Schot 2007)

In this environment different stakeholders collaborate: companies, users, public organizations and researchers. All of them can benefit from the LL approach: companies can get new and innovative ideas, users can get the innovation they want, researchers can get study cases and public organizations can get increased return on investment on innovation research (Ståhlbröst & Holst, 2012).

Another distinctive characteristic of LL is the real-life environment as the focus of research. Real-life contexts are much more than a more realistic scenario for validating proposals; they form an arena where new meanings can emerge, tacit knowledge can be captured, and the whole ecosystem can be validated. The figure below shows that conducting research in a real-life environment and integrating users as co-creators are central to LL. In comparison to other user-innovation methodologies these two characteristics appear to be the clearest differentiators for LL.

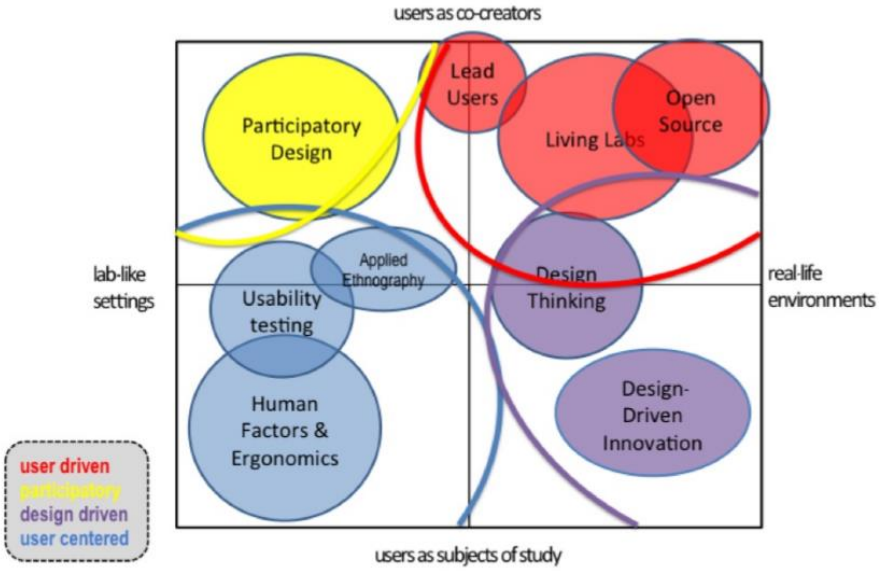


Figure 3: Mapping user-innovation methodologies (Almirall, Lee, & Wareham, 2012)

2. History of Living Labs: From lab to Living Lab

A laboratory as it is understood by the Oxford Dictionary is "a room or building equipped for scientific experiments, research or teaching, or for the manufacture of drugs and chemicals" (Lexico.com, 2020). Very similar is the Cambridge Dictionary´s definition as it states that a laboratory is "a room or building with scientific equipment for doing scientific tests or for teaching science, or a place where chemicals or medicines are produced" (Cambridge University Press, 2020). Acknowledging these two definitions makes clear that a laboratory is always set with a clear spatial structure (room), contains equipment to conduct scientific exercises and thus create scientific insights, includes the option of teaching (i.e. not only producing knowledge but communicating it) and is lastly strongly connected to a nature science-based way of thinking.

In the context of innovation research, MIT's Professor William J. Mitchell together with Kent Larson, and Alex (Sandy) Pentland were the first who started to construct home-like labs at the end of the 1990s. These first "living labs" were developed as scientific concept for observing how technology and humans interact. In these home-like labs the activities and interactions of its temporary inhabitants could be observed and manipulated. The main purpose of these LL was the testing and adapting of new technologies. The users were mostly involved as passive study objects, testing the suitability of technical solutions for daily use.

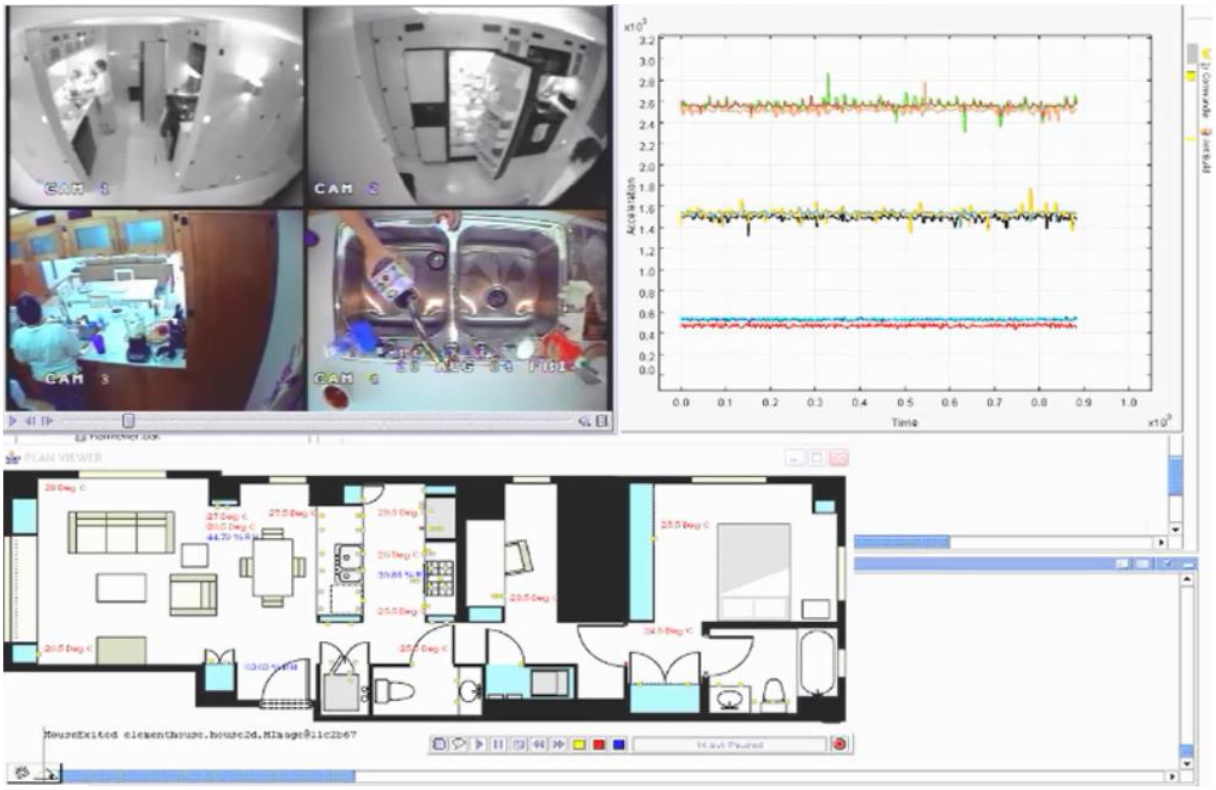


Figure 4: Research of user behavior in the PlaceLab, MIT (Intille, et al., 2005)

It was due to social sciences as well as ICT that laboratories were taken out of their original understanding and were "brought to life". LL thus take a step further trying to solve "complex solutions in multiple and evolving real-life contexts" (Eriksson, Niitamo, & Kulkki, 2005) that made laboratories "alive". As in many research fields which are social science driven there is no commonly agreed upon definition of what a LL is or ought to be. LL are an "experimentation environment in which technology is given shape in real-life contexts and in which (end) users are considered 'co-producers'" (Ballon, Pierson, & Delaere, 2005). LL are thus both, a "methodology and a milieu for organizing user participation in innovation processes" (Bergvall-Kåreborn, Ihlström Eriksson, Ståhlbröst, & Svensson, 2009). A wide range of further understandings of LL by (Følstad, 2008) (Fulgencio, Le Fever, & Katzy, 2012) (Dutilleul, Birrer, & Mensink, 2010) (Westerlund & Leminen, 2014) can be found in (Ballon & Schuurman, 2015). What is common to most understandings of LL is their acknowledgment of putting the user in the center. User centered research means that the to be researched "object" actively takes part in the research on itself by giving feedback and participating (Bergvall-Kareborn & Stahlbrost, 2009).

In publications by Bergvall-Kåreborn et al. as well as (Georges, Baccarne, Logghe, & Schuurman, 2014) and (Ståhlbröst, 2012) reoccurring criteria of what makes a LL essential are the following:

Openness: The more open and inclusive a LL is the more perspectives, knowledge and information can be part of the process. However, it should be acknowledged that different stakeholder group should be involved in different levels of intensity.

Realism: LL should be designed very close to the real live environment of the user. The living in LL therefore suggest that the research is conducted outside the actual laboratory to achieve unbiased results.

Empowerment of users/Influence: It is of important to motivate the users to actively engage in the LL experiment. Only that way innovative and interesting results can be achieved.

Spontaneity: As a LL is a very vivid method for doing research also the researchers hosting the LL need to be spontaneous to not lose the users attention

Sustainability: The LL itself as well as its result shall always be evaluated towards the principles of sustainability. Only with this approach a long lasting and effective impact can be achieved.

Value: As every lab also LL need to create value at some point in order to remain over time. These values can be monetary as well as values for the users.

3. Definitions of Living Labs

Various definitions on LL exist (Niitamo, Kulkki, Eriksson, & Hribernik, 2006) (European Commission Information Society and Media, 2009) (Bergvall-Kåreborn, Ihlström Eriksson, Ståhlbröst, & Svensson, 2009). We want to refer to a definition bringing together all the different aspects of a LL given by ENoLL. ENoLL - the European Network of Living Labs – is the international federation of benchmarked LL in Europe and worldwide. It was founded in November 2006 and counts today over 150+ active LL members worldwide (440+ historically recognized over 14 years). ENoLL is present in five continents in addition to Europe.

ENoLL defines LL as follows (ENoLL, 2020):

- LL are defined as user-centered, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings.
- LL are both practice-driven organizations that facilitate and foster open, collaborative innovation, as well as real-life environments or arenas where both open innovation and user innovation processes can be studied and subject to experiments and where new solutions are developed.
- LL operate as intermediaries among citizens, research organizations, companies, cities and regions for joint value co-creation, rapid prototyping or validation to scale up innovation and businesses. LL have common elements but multiple different implementations.

According to ENoLL a LL follows four main activities: co-creation, exploration, experimentation and evaluation (Mastelic, Sahakian, & Bonazzi, 2015).

- **Co-creation:** bring together technology push and application pull (i.e. crowdsourcing, crowd casting) into a diversity of views, constraints and knowledge sharing that sustains the ideation of new scenarios, concepts and related artefacts.
- **Exploration:** engage all stakeholders, especially user communities, at the earlier stage of the co-creation process for discovering emerging scenarios, usages and behaviors through live scenarios in real or virtual environments (e.g. virtual reality, augmented reality).
- **Experimentation:** implement the proper level of technological artefacts to experience live scenarios with a large number of users while collecting data which will be analyzed in their context during the evaluation activity.
- **Evaluation:** assess new ideas and innovative concepts as well as related technological artefacts in real life situations through various dimensions such as socio-ergonomic, socio-cognitive and socio-economic aspects; make observations on the

potentiality of a viral adoption of new concepts and related technological artefacts through a confrontation with users' value models.

LL are applied in different thematic fields. In chapter 7 of this report some examples are given. The following figure shows the diversity of topics addressed by ENoLL members. Health&wellbeing is on the top of the list, followed by social innovation, social inclusion and smart cities. One fifth of the ENoLL members is active in the field of energy. Although energy is not on the top, it appears to be a relevant issue for LL.

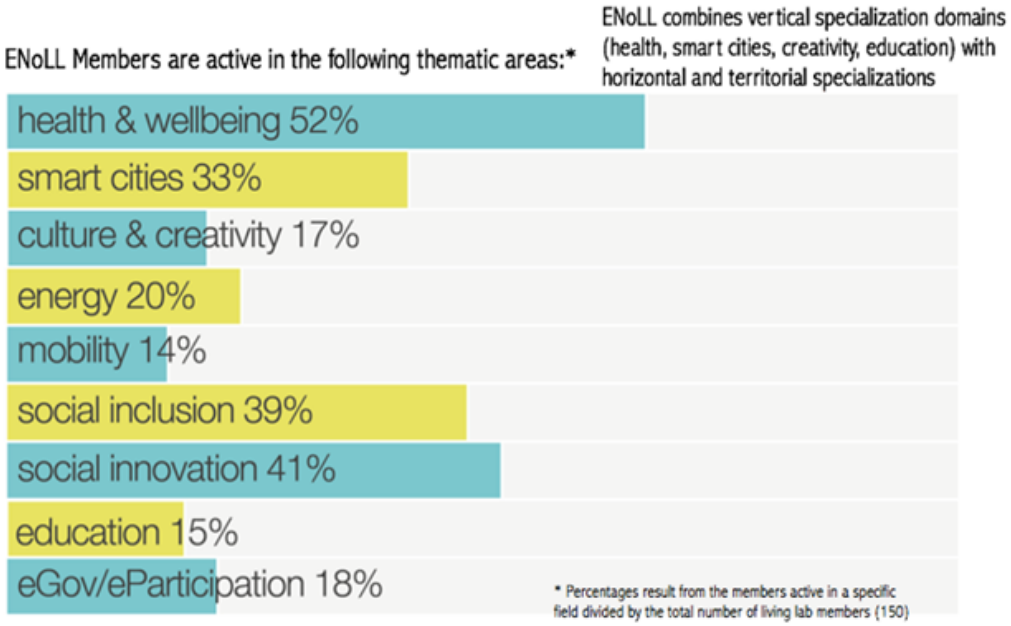


Figure 5: Areas of Work in the European Network of Living Labs (ENoLL, 2020)

Germany dedicated a whole program to the topic of LL for energy transition (or "Real-labore" as they call it): the funding program "Smart Energy Showcase - Digital Agenda for the Energy Transition" (SINTEG). In five model regions all over Germany more than 300 companies, research institutes, municipalities, districts and Länder have worked together since 2017 for giving answers to the question how Germany can make the energy transition a success. These five model regions were pioneers for "Reallabore". In the future, the approach of Reallabore will be continued (BMWi, 2020). As orientation for future Reallabore the German BMWi (Federal Ministry for Economic Affairs and Energy) published a handbook for regulatory sandboxes which employs a rather narrow, regulatory focus on the concept of Reallabore (BMWi, 2019). Whereas the social sciences frequently regard LL as experimental spaces at the interface of science and society in which solutions are primarily sought for societal challenges and transformation processes, the BMWi regards regulatory sandboxes as "areas in which to trial innovation and regulation".

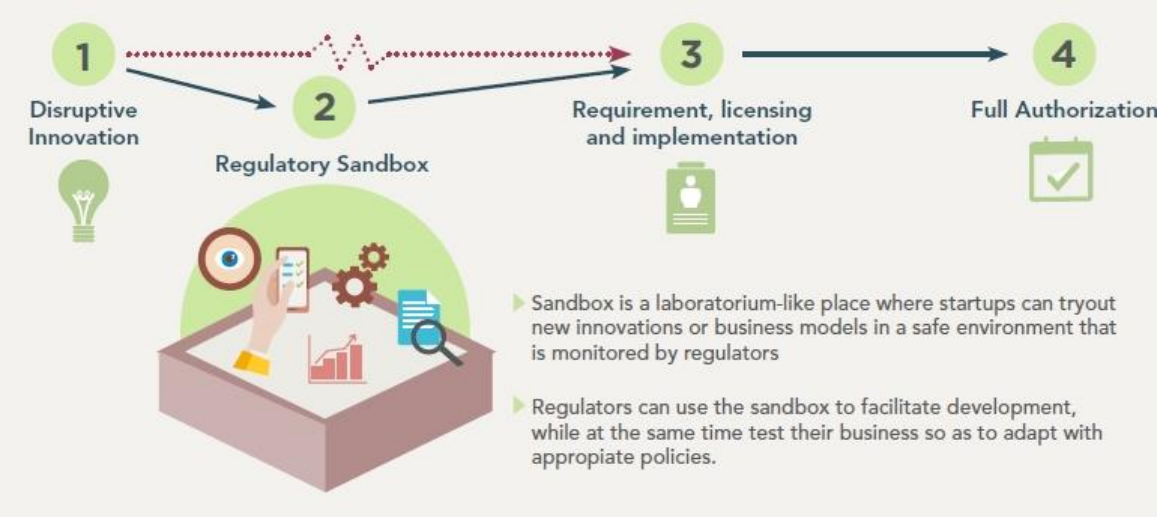


Figure 6: Regulatory sandbox model (PharmaBoardroom, 2018)

The following three elements characterize regulatory sandboxes (BMWi, 2019):

1. Regulatory sandboxes are test areas established for a limited time, covering a limited area, in which innovative technologies and business models can be tried out in real life. In many cases, innovative technologies and business models are not fully compliant with current rules and regulations, simply because the people who put the legislation in place could never have envisaged the new developments. In response:
2. Regulatory sandboxes make use of regulatory leeway. Experimentation clauses and other instruments to deliver flexibility make it possible to set up regulatory sandboxes even if the existing legal framework does not provide for the technologies or business models which are to be trialed.
3. Regulatory sandboxes entail an "interest in regulatory discovery". This means that the focus is not only on the innovation, but also on the question of what the legislature can learn for future legislation. Regulatory sandboxes will only result in better regulation if they involve a process of regulatory discovery.

4. Key Elements of Living Labs

Although there is not one single and commonly used definition for LL, some attempts have been undertaken to find most common features that different LL frameworks share. Key characteristics of LL outlined in a range of literature sources and publications (Hossain, Leminnen, & Westerlund, 2019):

- **User involvement** makes up the core of LL frameworks. However, it has been approached through few different avenues. The traditional approach involves users as real-life data and information providers. In this case users are seen as data source, confirming or neglecting the validity of data, services and/or solutions that are developed by experts, involved in LL. This approach represents traditional innovation networks or labs. The second avenue to user involvement corresponds to real LL and opens space for **users to be involved in the actual development process, driving the innovative solutions**. In this case, users themselves are an integral part of the innovation, going beyond the role of information/data sourcing and validation.
- **Creation of new services** is a specific aspect that many LL entail. The anchoring of innovative solutions in real-life context requires **setting up of new eco-systems, networks and infrastructure**, capable to link a range of users and stakeholders that have not been linked before. In this context, LL can enable shared infrastructure, platforms and networks that facilitate the co-creation process. This aspect is often summarized under the headline of **open innovation.**
- Governance structures of LL entail **diverse constellations of public and private stakeholder groups.** LL can be driven by different actors, such as users, providers, enablers and utilizers, depending on the expected outcomes and collaborative aims of involved parties. This feature of LL often pushes for **innovation across different governance levels**.
- LL employ **novel tools and methods** or design new combinations of tools and methods that enable the involvement of interdisciplinary actors and integration of diverse know-how needed to serve innovation.
- LL evolution is a **continuously developing phenomenon** that has not been entirely captured by the scientific literature. This topic contains great potential and **requires further in-depth research**.

The following figure illustrates the key characteristics summarized by Hossain et al. (2019):

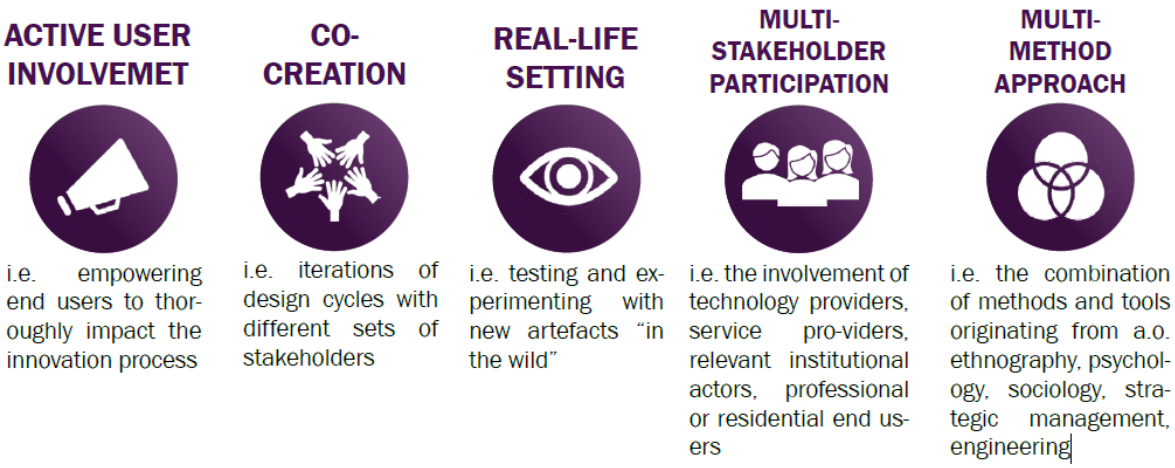


Figure 7: Key elements of Living Labs according to ENoLL (ENoLL, 2020) (Hossain, Leminnen, & Westerlund, 2019)

Active user involvement, co-creation and multi-stakeholder participation all need empowerment. The involvement of user communities means that users are not only observed subjects but also as source of creation. User-centered research methods, such as action research, community informatics, contextual design, user-centered design, participatory design, empathic design, emotional design, and other usability methods, already exist but fail to sufficiently empower users for co-creating into open development environments. Thus, for a true LL process, empowerment of users is key and makes all the difference.

For comparing, synthesizing and harmonizing different LL, it is necessary to define key elements and categories which can be screened and analyzed in each LL process.

From the innovation management literature five (ideal) categories of processes within a LL can be described (García-Guzmán, Fernández del Carpio, de Amescua, & Velasco, 2013):

1. Innovation initiatives management, or the core processes for accessing and involving user communities
2. Technical development focused on the engineering of solutions developed at the lab
3. Monitoring and evaluation, processes for tracking the success of lab initiatives and practices
4. Organizational management, which includes: strategy management and governance, technology infrastructure management, knowledge management, and stakeholder management processes
5. Deployment and operation, or processes for managing the user communities

These categories are also included in the comprehensive harmonization cube which gives an excellent overview of different aspects to be considered in LL processes. The structure

can also be used to monitor and evaluate LL in different stages for identifying gaps and further research needs (see e.g. (HSB Living Lab, 2020)).

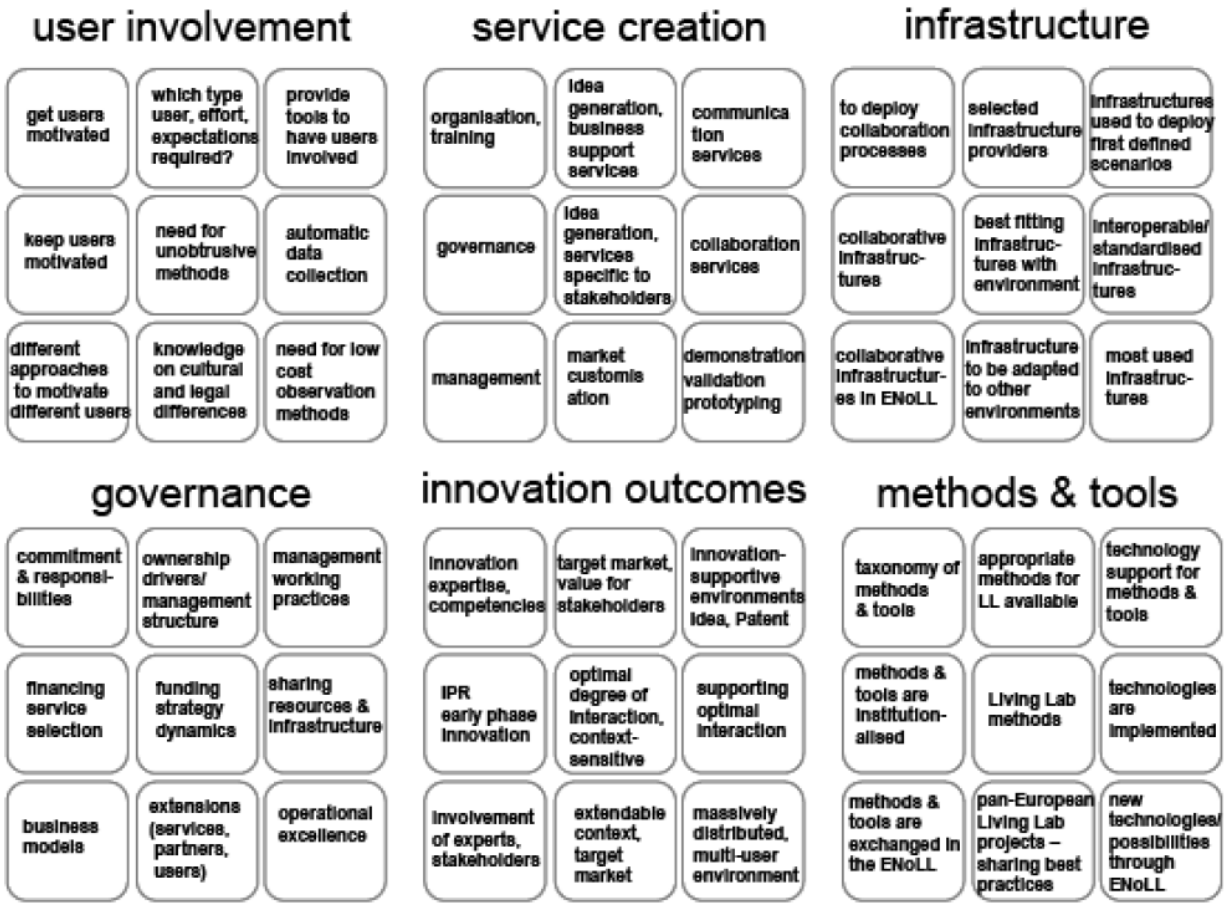


Figure 8: The elements of the harmonization cube (Mulder, Velthausz, & Kriens, 2008)

5. Actors, Roles and Stakeholders

Since the 2000s more than 300 LL have been registered in Europe (Hagy, Bard, Sasic Kalagasidis, Sredanovic, & Camarasa, 2017). A significant number of studies have been conducted to analyze different approaches, challenges and the main benefits of the method. The variety of LL and the fields they are used in shows the flexibility and the common basics. But which actors and roles are needed in a LL?

LL operate as intermediaries among citizens, research organizations, companies, cities and regions for joint value co-creation, rapid prototyping or validation to scale up innovation and businesses (Vaittinen, 2020).

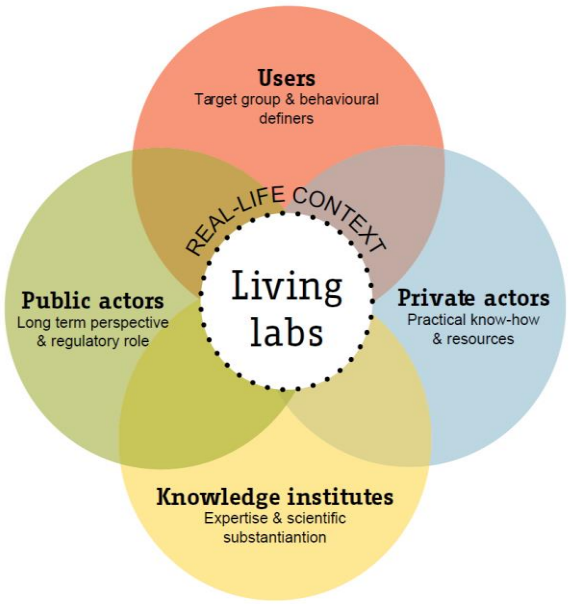


Figure 9: Central actor groups in Living Labs (Steen & van Bueren, 2017)

Thus, important actors are all these different stakeholder groups which are represented in the so called "quadruple helix".

Quadruple Helix

The Quadruple Helix model is user focused and follows an innovative and collaborative approach (Värmland County Administrative Board, 2019). Especially within a process that is operating on behalf of the user's needs (e.g. health care, public e-services) it is essential to include the knowledge of diverse actors. Hence, the Quadruple Helix offers the end-user to play an active role together with other stakeholders (see Figure 10).

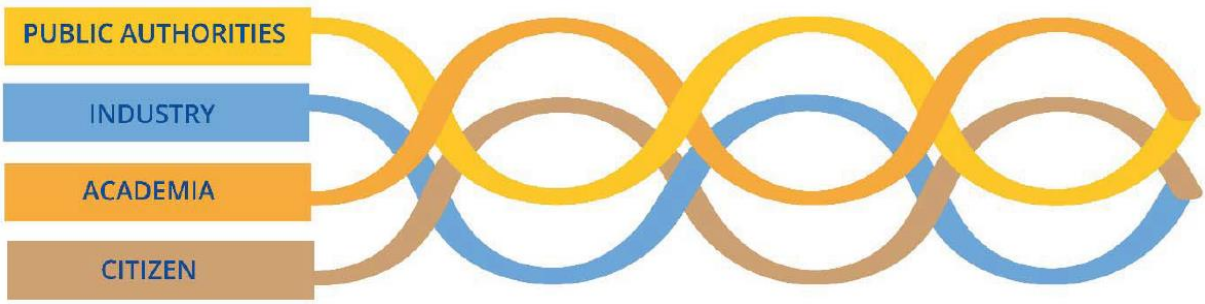


Figure 10: Visualization of the Quadruple Helix approach (Värmland County Administrative Board, 2019)

The Quadruple Helix evolved out of the triple helix theory (Etzkowitz & Leydesdorff, 1995), (Etzkowitz & Leydesdorff, 2000) by adding as the fourth helix "civil society" (Afonso, Monteiro, & Thompson, 2012), (McAdam & Debackere, 2018), (Miller, McAdam, & McAdam, 2018). It has to be mentioned that further helix theories developed in the meanwhile such as the Quintuple Helix by extending to the social and environment ecology (Carayannis & Campbell, 2010), (Carayannis, Grigoroudis, Campbell, Meissner, & Stamati, 2018) and the N-Tuple Helix (Leydesdorff, 2012), (Park, 2014a), (Park, 2014b.).

Staying with the 4 main actor groups of the Quadruple Helix, the actors should be chosen with the aim to have a reasonable number of representatives of the society with:

- public authorities (e.g. government, regional development agencies, policy makers)
- industry (e.g. businesses, business clusters)
- academia (e.g. university, research & development bodies)
- citizens (e.g. end users, interest groups)

The way of user involvement can differ within every single process, as it strongly depends on the background and role of the actors. The goal of every method used should be the inclusion and motivation of all relevant actors and therefore sometimes calls for multiple methods.

As actors have different interests, goals, power, influence and capacities, it is important to clarify their role in the first stage of the LL process. Thus, a stakeholder mapping is a valuable approach for getting an overview of the actors themselves and about their roles. A good tool to use to help identifying stakeholders is PESTLE which stands for Political, Economic, Social/Cultural, Technological, Legal and Ecological. In a second step the role of the stakeholders can be analysis. Relevant parameters could be (Manchester Metropolitan University, 2020): What´s their stake in the project, what´s their impact, what do we need from them, what´s the perceived risk from their perspective, how are they included in the stakeholder management strategy and what´s their responsibility in the project.

The following figure gives an example of a stakeholder mapping showing the different degrees of relevance and involvement in the process. The actors are located in different "layers" – from core actors in the inner circle to parties partly involved in the outer layer. The colors reflect the different actor groups – citizens, company, authorities/administration and politics.

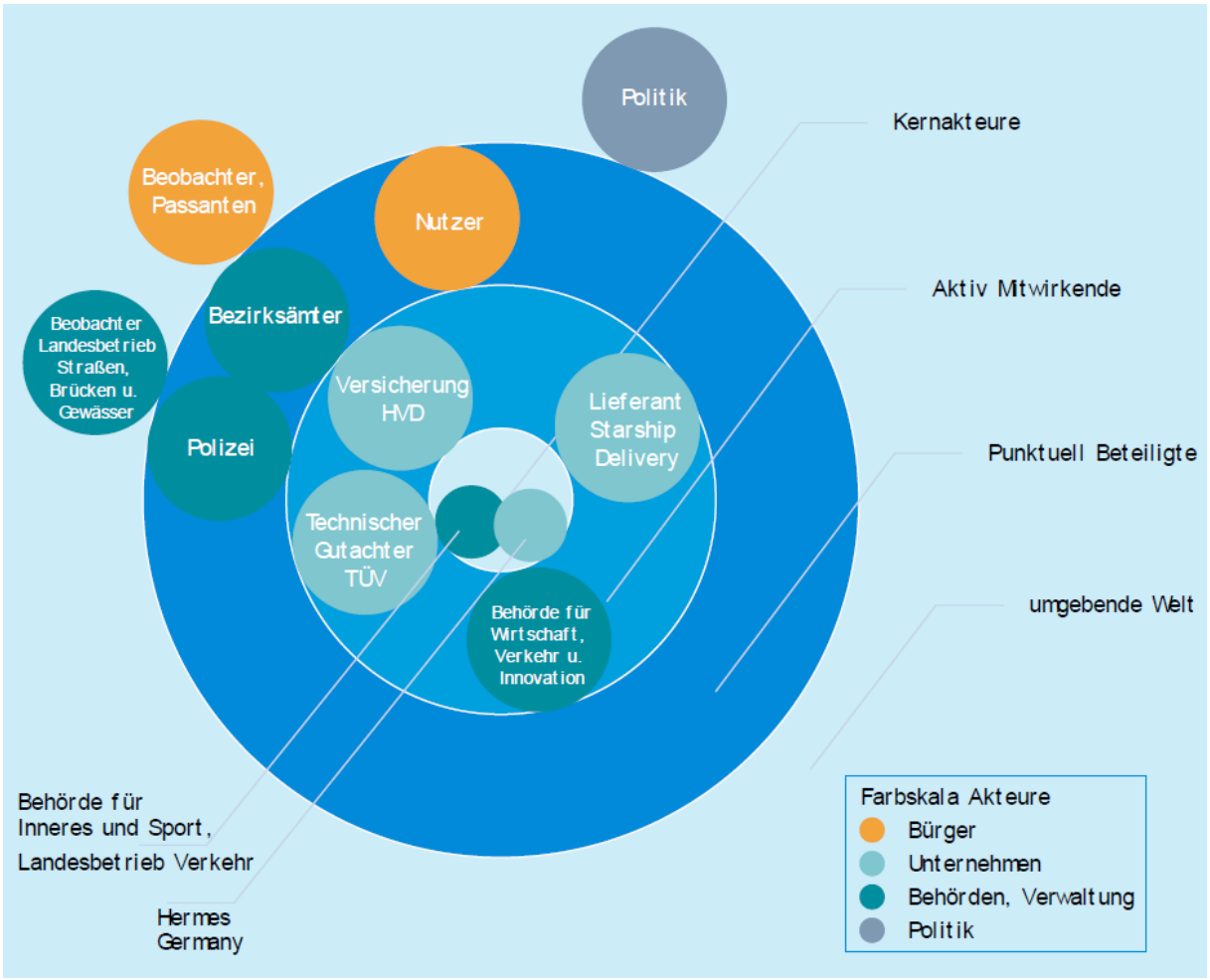


Figure 11: Example of actors located in different "layers" of a living lab process (Brandt, Bullinger, & Duisberg, 2019)

For stakeholder mapping it can also be useful to start from the roles relevant in a LL process. FALL – the Framework for Agile LL – identifies 9 different roles (Imec Application Prototyping and Living Labs, 2020):

- **Process Manager:** guides the team
- **Product owner:** makes sure that the project meets the needs of the users & stakeholders; has the skills to understand the needs of the end-users, rather than pure technical skills.
- **Researcher:** gets input from users
- **Architect:** creates the systems architecture

- **User Experience Designer:** creates the designs that represents the graphical user interface
- **Developer:** translates the story back-log into functional applications
- **User Involvement Coordinator:** makes sure that participants stay motivated throughout the project
- **User:** who will eventually use the outcome of the project
- **Stakeholder:** operates from a policy, commercial or academic point of view

Although the structure of FALL is clear and practical, the 9 different roles seem to be a mixture of roles (e.g. Process Manager, Product owner, User Involvement Coordinator) and actors (Researcher, User, Stakeholder). The following list of Nyström et al. is more precise and focused on roles. They conducted 26 case studies on LL and identified 17 different roles within (Nyström, A., Leminen, Westerlund, & Kortelainen, 2014).

Case #	Webber	Instigator	Gatekeeper	Advocate	Producer	Planner	Accessory provider	Coordinator	Builder	Messenger	Facilitator	Orchestrator	Integrator	Informant	Tester	Contributor	Co-creator
1		x	x	x			x				x		x			x	
2		x	x	x	x		x				x		x		x	x	
3		x	x	x			x				x		x			x	
4		x	x	x	x		x						x		x	x	
5	x	x		x	x		x				x		x		x		
6	x	x		x	x						x		x		x	x	
7		x		x	x	x					x	x				x	x
8		x		x		x	x				x	x			x	x	
9	x	x		x	x	x	x	x	x		x						x
10						x					x	x				x	x
11	x	x		x	x	x	x				x		x		x	x	
12	x	x		x	x						x				x	x	
13	x	x		x	x						x					x	
14	x	x		x	x						x		x		x	x	
15		x		x		x					x		x	x		x	x
16		x		x		x	x				x		x	x	x		x
17		x		x	x	x					x		x	x	x	x	
18		x		x			x							x		x	x
19	x	x		x		x					x		x	x	x	x	
20		x		x	x	x					x	x		x	x	x	x
21	x	x		x	x		x				x			x	x	x	
22	x	x		x	x		x				x			x	x	x	
23	x	x		x		x					x			x		x	
24	x	x			x	x		x	x	x	x			x		x	
25	x	x				x		x	x	x	x			x		x	
26		x		x	x	x	x				x	x				x	x

Figure 12: Summary of roles in 26 living labs (Nyström, A., Leminen, Westerlund, & Kortelainen, 2014)

6. Methodology of Living Labs

Theory

A crucial part of LL is the choice and application of the right methodologies. There is a potpourri of different methods used in all kinds of participation and user processes as well as workshops.

According to Arnstein's ladder of citizen participation there are various levels of citizen participation in organizational decision-making. Arnstein differentiates between 8 different rungs on the ladder from the lowest rung (manipulation) to the highest one (citizen control) (Arnstein, 2007) (Lane, 2019). The IPG (Institut für Partizipatives Gestalten GmbH) uses a simplified three-step ladder, reflecting the main characteristics of participation (Rohr, 2018):

Informative

The informative method enables participants to react to information, but it doesn't give any real power. The information is presented in a transparent way and from time to time participants can vote or get answers to their questions. Examples: informative events.

Deliberative

This method is similar to the informative process but with deeper communication among all participants in form of public gathering, arguments and again voting. The participants have slightly more power compared to the informative method. Most of nowadays participation processes are organized in an informative or deliberative way. Examples: world café, town hall meetings.

Collaborative

Another approach is realized in the collaborative method where concrete processes of co-operation are the main focus. It utilizes not only the opinions and thoughts, but also the abilities and the potentials of all participants. Within the collaborative method there is a productive development process which leads to concrete and realizable results (e.g. concepts, laws, projects, products, places). The main difference to the before mentioned methods is its procedural, methodical and design-oriented development of solutions. A typical example of collaborative processes are LL.

Figure 13: Different forms of participative methods (Rohr, 2018) (Arnstein, 2007)

Co-creation needs a true collaborative approach. As there is often a confusion between different forms of collaboration, three types often used in the context of innovation are described below:

Open innovation: Innovation with the help of external stakeholders. This can be competitors, customers, suppliers, legislators and so on.

Crowd sourcing: It takes place when an organization outsources projects or topics to the wider public. Crowd sourcing comprises a lower level of involvement, where an organization presents a challenge to the public and asks for opinions, insights and suggestions.

Co-creation: Compared to open innovation and crowd sourcing, co-creation therefore means working with the end users of the final product or service.

The three concepts can be very well explained with the help of an example. Presumed, we are an automotive company and want to design a flying car. It all begins with the **open innovation** approach that we address an aircraft company to cooperate and create a flying car. This car is eventually marketed by a joint venture in which both companies participate. If it would be **crowdsourcing**, we as automotive company would announce that the creation of a new type of car is planned it is open to everybody to submit ideas and concepts. We would then make a choice of the most feasible solutions. **co-creation** on the other hand is the further improvement of an existing innovative automotive project in which users provide input for improvements that are ultimately positively received by the masses. (Variera, 2020)

The following table compares the relevant dimensions of three user-oriented innovation concepts.

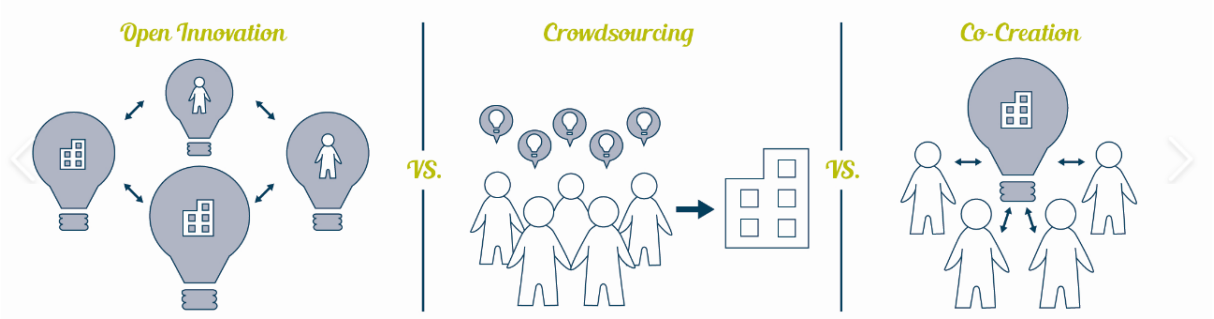


Figure 14: Dimensions of user-oriented innovation concepts (Variera, 2020)

As every LL process has specific framework conditions, contents and goals, the right and suitable methods depend on the setting of the specific LL. The LL shapes the whole process – like a bottle. The content of a LL can be very diverse, thus not every method fits every LL.

Sometimes a comprehensive framework is needed comprising a lot of different methods and partners, sometimes a framework is applied which allows for playful methods and gaming attracting e.g. young people and sometimes a practical framework can be useful with a lot of hands-on methods. Thus, one of the first steps in setting up a LL should be executing a status quo analysis of the LL which includes the setting of the framework and/or context of the LL and the definition of the lab itself. Furthermore, a stakeholder mapping (see Figure 15) and the development of a portfolio of methods is needed (Urban Green Belts consortium, 2020).

Figure 15: Every LL needs its specific framework (="bottle") shaping the process

Throughout the entire LL process different forms of user participation have to be considered.

1. Already in the phase of contextualisation and idea generation it is essential to identify, select and mobilize key stakeholders and users.
2. After developing a rough concept, the idea gets more concrete and a detailed concept emerges. In this step the co-creation/exploration/experimentation/evaluation-cycle (Hagy, Bard, Sasic Kalagasidis, Sredanovic, & Camarasa, 2017) is especially important as it steers the following implementation which involves high costs. Often user participation is neglected in this early stage. The co-creative and interactive approach of LL helps to involve the users right from the start.
3. In the stage of implementation, it has already become more common to integrate users. Interviews, focus groups, workshops, public trials etc are all useful methods during implementation.
4. Although it should be part of every stage, special focus should be laid on feedback in the finalization phase.

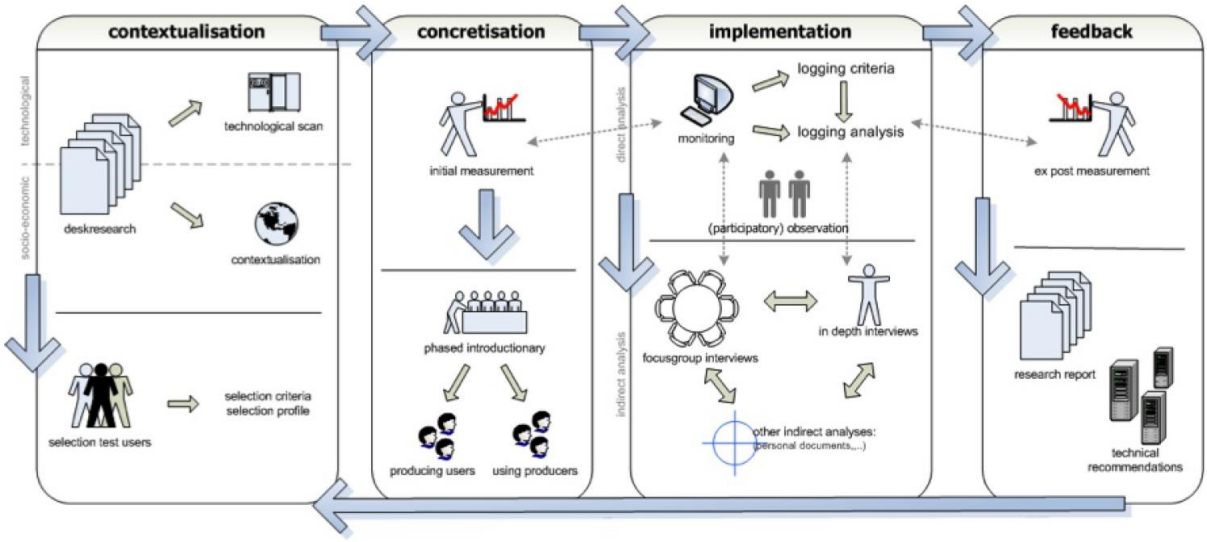


Figure 16: Living Lab methodology of the project iLab.o (Almirall, Lee, & Wareham, 2012)

Examples

In the following chapter specific methodologies were selected and described in detail. As not all methodology can be displayed this should give an impression of the wide range of existing methods with classical and innovative approaches. Also, there is a box with an overview in which aspect the method can contribute the most, which are:

- Types of outcomes
- Suitable number of participants
- Types of participants
- Length of process

The colored statements are applicable for the specific method. For deeper insights and more inspirational methods it is recommended to visit the websites of INTERREG Central Europe with the "Toolbox of Smart Participatory Methods & Tools"[1] as well as the website on participation from ÖGUT and the Austrian Federal Ministry for Sustainability and Tourism[2].

The following visualization serves as an overview of the selected methodologies in this report and gives a recommendation in which phase it suits best to engage with the participants:

[1] https://www.user-participation.eu/

[2] https://www.partizipation.at/methoden.html

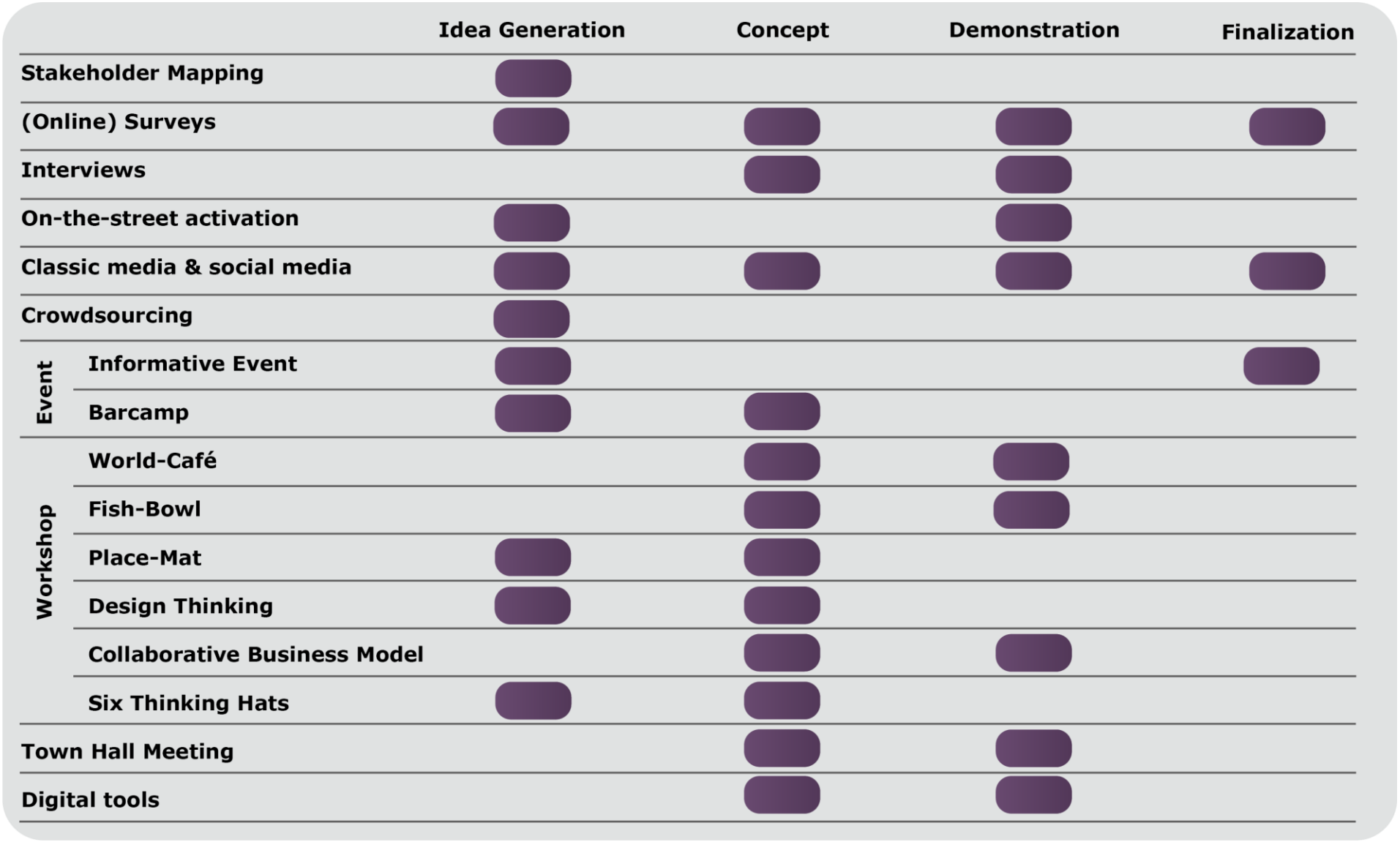
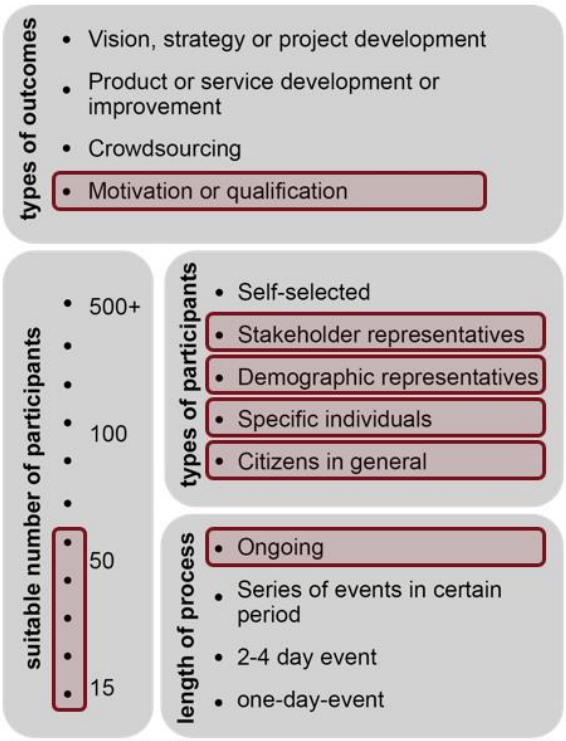


Figure 17: Overview of methodologies assigned to the suitable phases of a Living Lab

Stakeholder-Mapping



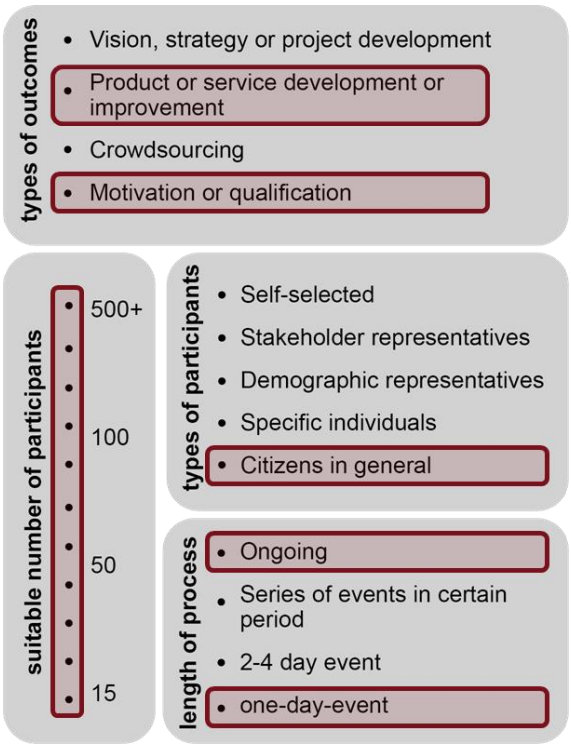
In the beginning of a LL it is essential to carry out a comprehensive stakeholder analysis including the civil society. In relation to the desired results of the lab, the target groups and their motives have to be identified. For a LL it is always a challenge to avoid being a circle of like-minded people sharing attitudes and goals that do not correspond to those of the majority of citizens. The reason can be that certain groups are not interested in joining the activities of the LL because they do not see a personal connection to the topic for themselves or because they have conflicting views. In the LL, often those groups of people are not sufficiently represented which are actually affected by the issue. That's why it is important to involve key persons who ensure a holistic and interdisciplinary perspective. A stakeholder mapping can prevent or at least minimalize the exclusion of target groups and also helps later on in defining the right communication and methods towards different groups. Another issue is the fact that the organizational structure of a LL or methods used cannot always ensure that all actors have the same opportunities for participation and discussion. For example, politicians, technical experts or male participants are often more likely to be heard. A regular execution and reflection of a stakeholder analysis to understand social structures and power relations is not only important in the beginning but throughout the total running period of a LL. This way dominant groups of people with possible relations to their institutional role outside of the lab can be identified and measures can be undertaken. Repeated stakeholder analysis can ensure that relevant actors are not overlooked and changes in the external framework conditions can be included. (Dijk, et al., 2019) The PESTLE method is very advisable for stakeholder mapping. It is a central model for an external environmental analysis. It has already been described in chapter 5 in a more detailed way and should be summarized here. The initial letters of PESTLE stand for the following impact factors that should be identified in a LL process (Salzburg Research, 2020):

- **Political factors** (subsidies, trade policy, fiscal guidelines, legislation, political stability, etc.),

- **Economic factors** (economic growth, key industries, interest rates, inflation, exchange rates, unemployment, taxation etc.),
- **Socio-economic factors** (population structure, education; demography, mobility, values, attitudes, behavior etc.),
- **Technological factors** (research, new products and processes, product life cycle, new information and communication technologies - innovations, energy supply etc.),
- **Legal factors** (existing and future legislation, patent protection, competition law, certification etc.),
- **Environmental factors** (manufacturing processes, environmental protection requirements, availability of raw materials, emissions trading etc.).

The factors are closely related to each other. If individual influencing factors change currently or in the future, this usually affects the factors themselves and has an impact on the organization of a LL. First, there should be a brainstorming on all the factors part of the PESTLE method, predefined questions related to the environment of the specific LL may help (e.g. trends, framework, external influences). Then a prioritization of the factors should follow that is related on the impact it will have on the LL. (Salzburg Research, 2020)

(Online) Surveys



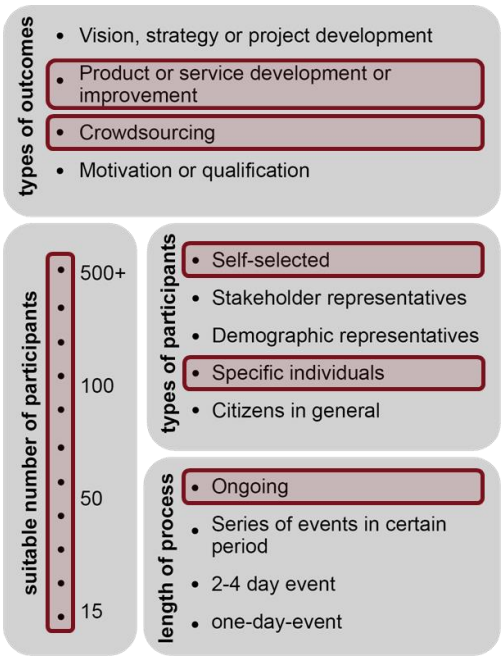
Surveys are a useful method to gain insights into the views and opinions of the participants on specific questions. The evaluation of the answers has impacts on the further steps undertaken in the project. Repeating surveys make it possible to get insights on the (changing) mood of participants. There are several forms of surveys:

- Classic survey
- Online survey
- Activating survey

The classic or online survey includes a prepared questionnaire and is mostly of quantitative interest. The activating survey is a more qualitative way and asks directly for the citizens´ or users' opinions and attitudes. At the same time, it stimulates and encourages the respondents to stand up for their interests and participate in the development of solutions in their living environment through specific questions in this direction. The results of the survey are evaluated and presented to the target group with the aim of defining implementation steps. Interest or action groups are formed for the implementation. Unlike most conventional surveys, activating surveys are not executed only once. Rather, activating surveys are the starting signal for a longer-term process and require corresponding organization and implementation. (BMNT, 2020)

Interviews

Interviews are a valuable method for LL as they give deep insights on individuals in a qualitative way. The basis of an interview is to trigger reactions in the interviewees by means of linguistic interventions (oral or written), with the aim of obtaining specific thematic statements and information. A first step towards an interview is to define the dimensions of the interview, which are type and extent of standardization, style of communication, individual vs. group interview, form and medium of communication, objective of the interview. There are different types of interviews, e.g. (Halbmayer & Salat, 2020):

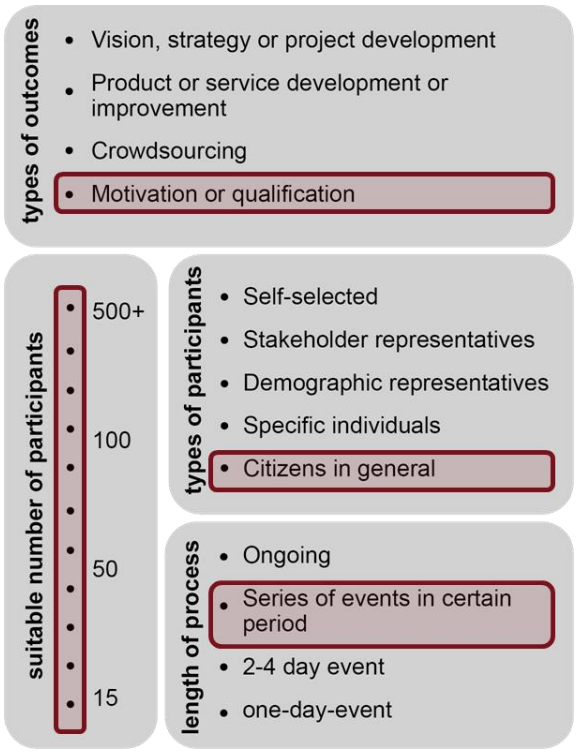


- guided interview
- narrative interview
- expert interview
- focused interview
- problem-centered interview
- postal interview
- standardized interview
- structured interview
- semi-structured interview
- non-structured interview

Interviewers should be experienced with interviews of the specific target group and well prepared. The LL of Griesplatz in Graz/Austria used the method of semi-structured interviews with stakeholders to get in-depth insights to relationships and data gathered in the project. The weaknesses of this method are mainly the high time-consumption and in this regard also the costs. (Dijk, et al., 2017)

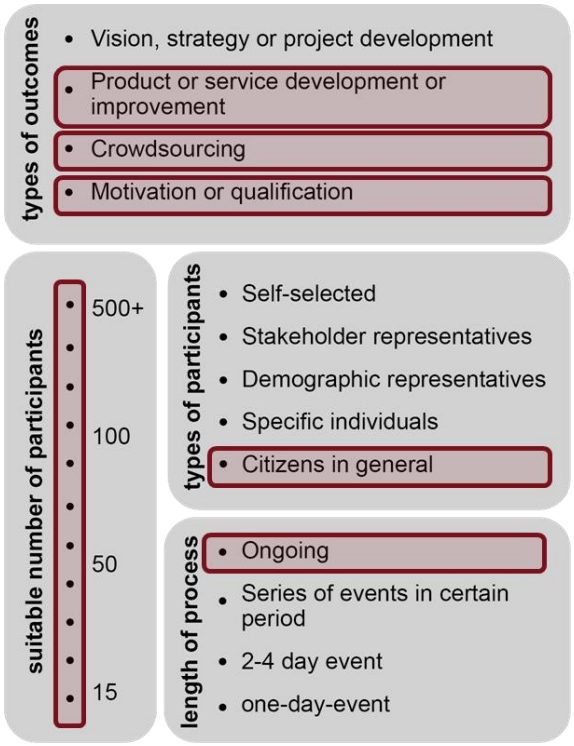
On-the-street activation

For a LL it is very important to activate a variety of people to take part and contribute with their different backgrounds and perspectives. One way to do this is the on-the-street activation, which was for instance used in the project LiLa4Green (see page 48). A team is sent to a public space, that is desirably connected to the topic of the LL, to approach people on the street. Different ways can be used to attract people to stop by. An example has been set by the LiLa4Green project as they integrated game-like activities with a so called "Bean-poll", where people had to document their perception of heat waves. This method helps to mobilize people in taking part in certain events, but it also supports the team in understanding the area and/or the citizens. (Tötzer, et al., 2019)



Traditional and Social Media

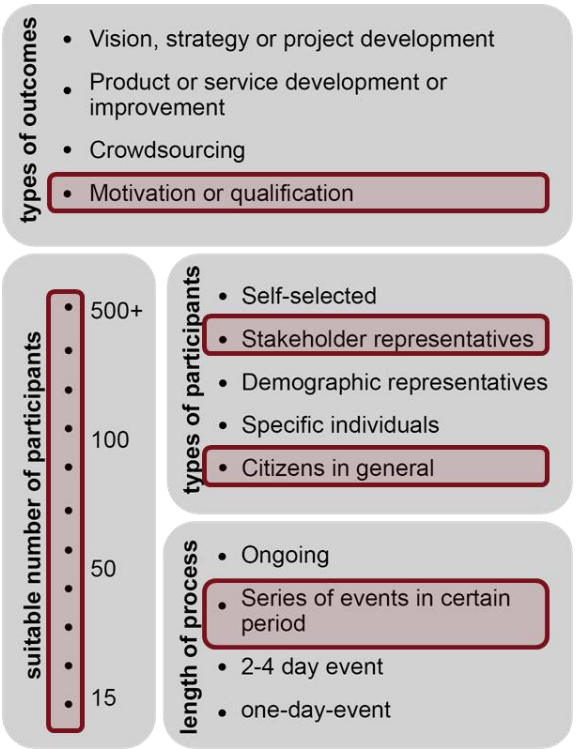
Traditional media (e.g. television and radio) and social media platforms (e.g. Facebook, Twitter, Instagram, YouTube, Snap Chat) can enhance citizen engagement. Media enables the interaction with people through the posting of activities or questions. Furthermore, some social media platforms offer the opportunity to execute live streaming or polling options for a specific topic. The participation in television or radio shows is another possibility for people to interact directly but digitally. (ParlAmericas)



Events

The organization of events makes sense if a higher number of people should be included. The main goal is to communicate the topic to a broader public and collect feedback, new ideas or knowledge. In the following the method of the Informative event and Barcamp is explained in detail:

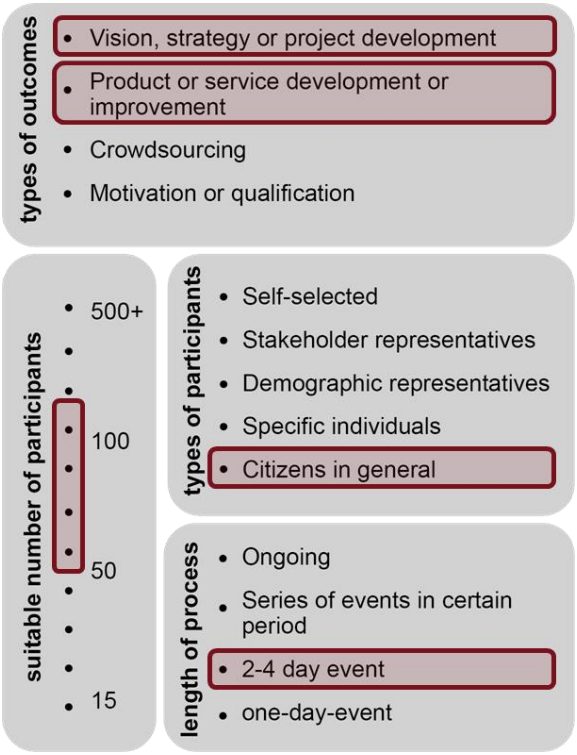
Informative event



Informative events are part of the classic methods utilized in different formations where everybody knows what to expect. It is a first attempt to inform people about a certain topic, product or organization. Furthermore, it serves as a platform to communicate outcomes and results. Although it may be a presentation and gives the opportunity to interact with the participants through questions & answers as well as discussion and personal exchange afterwards. The time and place of the informative event should be convenient for the attendees and it should be advertised on several channels (e.g. press, flyers, social media, posters, homepage). The event should inform about the framework of the LL, the goals and next steps. It is important to give the attendees an impression which persons are working at the project and who else is involved (e.g. municipality, stakeholders). Information material available during the event is important for attendees to have a closer look at the project at home. (Bürgerstiftung Hamburg, 2020)

Also, they should be asked if they want to get further information, for example in form of a newsletter, and contact details should be collected to keep them on track.

Barcamp



The crucial thing about a Barcamp is that the participants design and organize the event themselves. This principle is the basis for the entire Barcamp event and leads to the fact that each person is in the middle of it and not just watching while others are busy with different tasks. This starts with the arrival and the welcome, continues with the setting and organization of the agenda and ends with the clearing of the material and dishes.

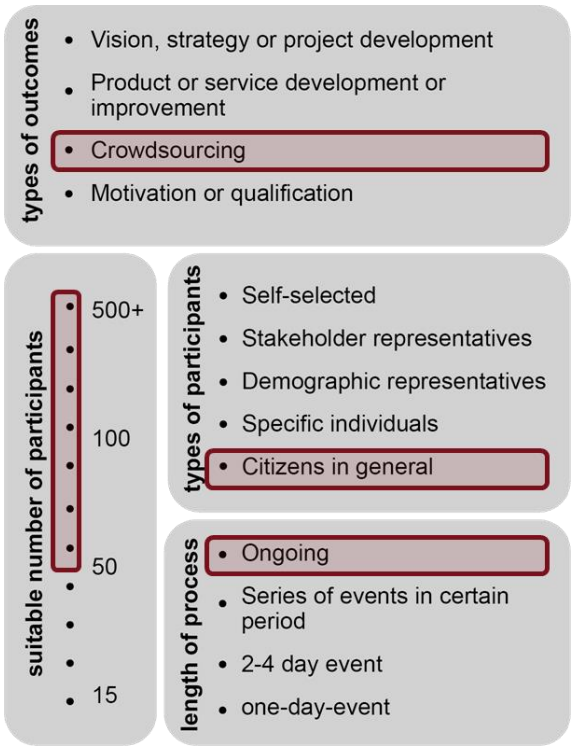
At the beginning of the event, all participants introduce themselves with three keywords in a brief and concise way regarding the following question: What did I bring today? After the introduction, everyone is asked to offer a so-called session. All topics and every single participant are seen as equally good and valuable. There is also the possibility to use a question or a problem to offer a session. With hand signals participants vote for topics, the ones with the highest interest are executed during the event. This ensures that the session topics will also find interested people. (Enera, 2020) A Barcamp ensures the exchange of knowledge and information in an open, voluntary, self-motivated, informal and democratic way of communication. A suitable space and internet access are the key elements of a Barcamp. The main advantages of using the Barcamp format are the generation of new (practical) knowledge, creative and surprising outcomes in form of new ideas and new synergies through an open, interdisciplinary and networking oriented approach. (Dennerlein, Gutounig, Kaiser, & C., 2015)

Within this method it is possible to set a rather open topic for a rough orientation, but the focus should be on the topics coming from the participants themselves.

Crowdsourcing- Online citizen engagement

The online citizen engagement with the crowdsourcing method enables the participation via a free-access online platform on a specific topic. There are 5 different types of crowdsourcing:

- Opinions
- Ideas
- Funds
- Tasks
- Data

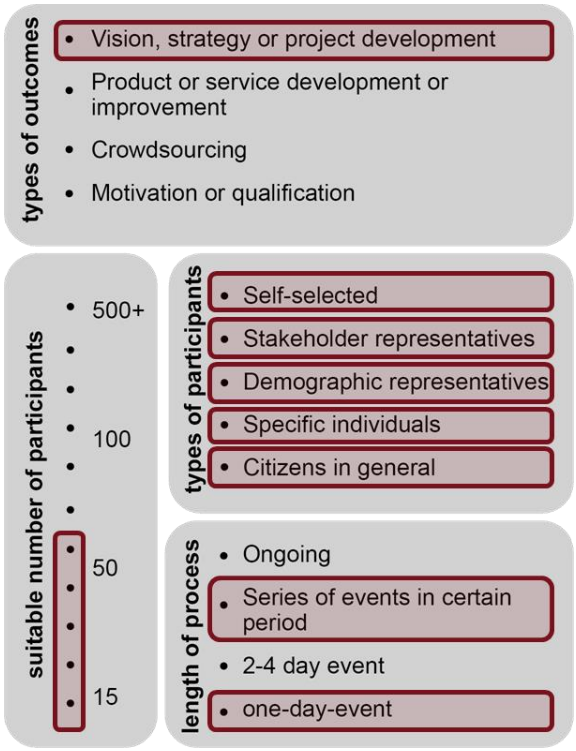


The method of crowdsourcing is very suitable to reach a large number of people. It helps to identify problems, execute analysis and develop and/or improve specific solutions. Advantages are a higher acceptance rate and a simplified chance to activate marginalized or vulnerable groups to take part in this particular citizen engagement process. The method can be utilized in any phase of a project. Nevertheless, it is recommended to use it in a stage where no decisions are taken to gather more inputs in other stages. Those inputs can be structured or unstructured opinions in several thematic fields of public interest. The method needs some preparation in sense of the target group that should be reached and the type of communication channel, especially if only a specific group of citizens should participate (e.g. residents of city quarter, solar panel owners). It is of high importance to prepare the topic as simple and understandable as possible and ensure that it is of public interest. Another aspect is transparency to explain why something is collected, for which purpose it is used and how the participants have access to the results. Of course, the results should be implemented in final decisions and a revealing report to guarantee the communication of outcomes should be mandatory. (Solutions, 2017)

Workshops

An essential part of LL is the organization of Workshops. It is a chance for the participants (stakeholders, citizens, users, project team etc.) to work on a specific topic in an intense and direct way. The interaction with other participants and the collective thought are an important part of each Workshop. The aim is to collect ideas, get feedback and/or develop a concept within a field of interest. There is a huge amount of different methods suitable for Workshops and the following only represents a few:

Workshops: World-Café



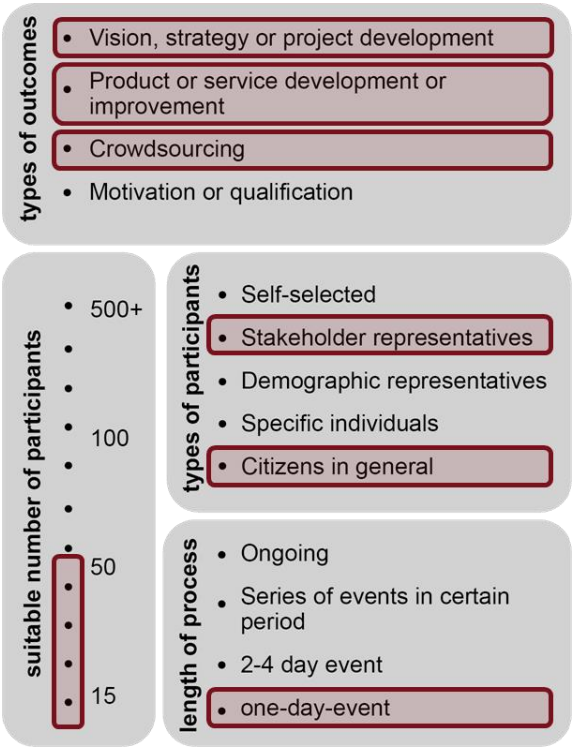
A well-known method for workshops is the World-Café, which is a structured discussion process for open and intimate discussion. The ideas are generated from "collective intelligence" of the group and several perspectives are included. The method is very suitable for a deeper insight on research or innovation topics. The atmosphere is one aspect that distinguishes the World-Café method from others. A typical café atmosphere should be created to represent informality and intimacy. An ordinary meeting arrangement can be avoided by placing small round tables with writable table clothes, plants on it and an outdoor view. This method is particularly recommended for a heterogenous and mixed group of participants that want to discuss a single common theme. At each table and in each round the same topic is discussed in order to allow an exchange of all participants and collecting all opinions and perspectives. The answer shouldn't be predetermined but the method is rather encouraging the exploration or innovation of solutions in a topic. Therefore, a World-Café is useful for a combination of different views on a topic, to design an action plan within in a short period, to develop consensual strategies etc. First the purpose of a World-Café session should be defined and according to it representatives of the target group should be approached. The representatives should be as diverse as possible but still have a relation to the focus topic. The organizers have to be aware that conflicts may arise when representatives of different background take part. A World-Café comprises three stages:

- **Preliminaries:** establishing planning team, definition of target group, time planning, location, moderation, catering, materials, invitation, communication and use of results

- **Implementation:** event itself
- **Wrap-up:** analysis and further use of the results

The moderation of the World-Café is a key aspect and should be well organized, e.g. with a professional moderator. The moderation has to explain the World Café etiquette in the beginning (e.g. focus on what matters, link and connect ideas). Also, table hosts should be defined in the beginning. Their task is to stay at the table and keep the overview of what was said and explain it to newcomers as the other participants are changing the tables. After several rounds the table hosts present the results and a reflection phase is executed. The final part, besides the gathering at a buffet for exchange and networking, is an explanation where to find the results. (Solutions, 2017)

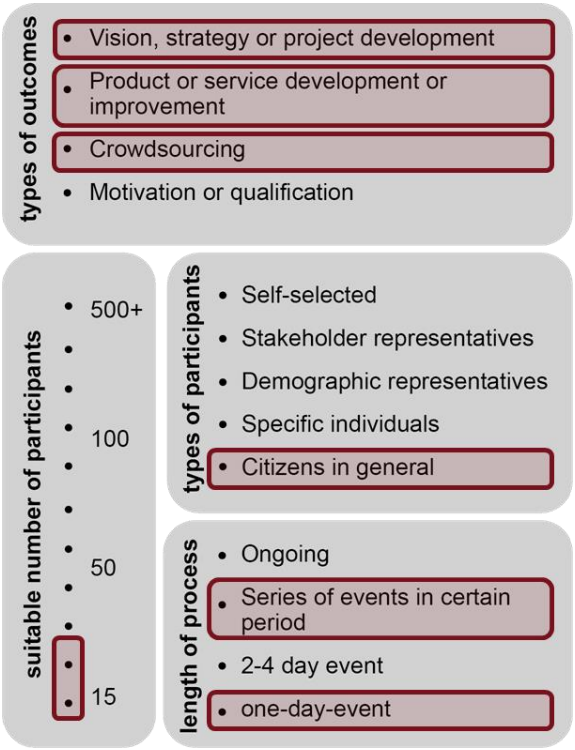
Workshops: Fish Bowl



The Fish Bowl is a simple but dynamic alternative to the panel discussion. By combining a large event with the advantages of small discussion groups, liveliness and spontaneity are brought to conventional event formats. It is suitable for the presentation of group results, disputes and open discussion processes and the representation of partial interests in a larger group.

A specific number of participants (often experts, decisions makers, stakeholders, etc.) sits in a small circle of chairs in the middle (4-6 chairs), all other participants sit in one or more circles of chairs around them. Only the people in the innermost circle are allowed to speak in the form of a direct discussion. Persons in the outer circle listen but can go to the inner circle and join in the discussion at any time. He/she either sits down on a free armchair (variant: an armchair of the inner circle remains free for spontaneous input from the outer circle) or stands behind a chair. The person in this armchair is allowed to finish formulating his/her thoughts, ask a question, briefly join the discussion and then leaves the circle again. In practice, after an initial uncertainty, a coming and going develops without breaking off the debate. The participants can consist of citizens, representatives of interest groups, representatives from politics and administration and/or experts. For the fish bowl method, it is important to avoid speeches and talk to each other instead. It is less suitable for a decision-making process, as it is not possible to determine how many participants hold which position. (BMNT, 2020)

Workshops: Place Mat

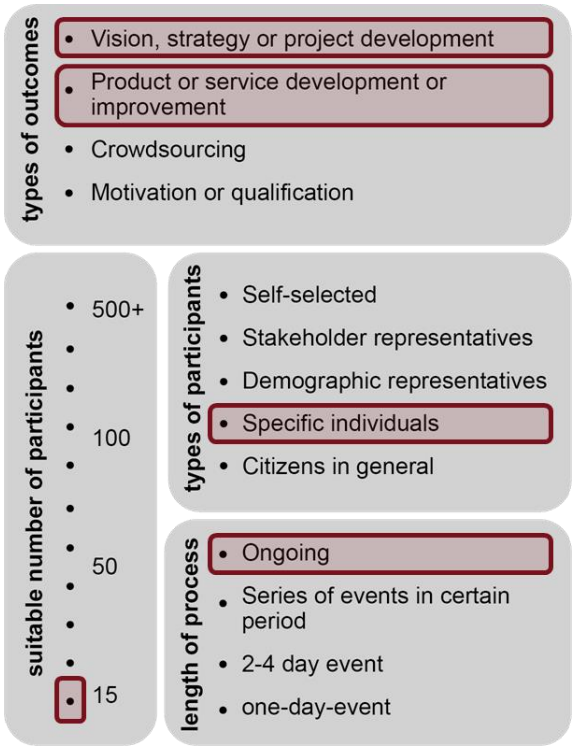


The Place Mat method is enhancing the collaborative generation of concepts, ideas or content between several people. It is originally used in schools as a teaching method but also suitable for LL workshops. Different tables with individual topics or concepts are set up in the beginning. Groups of 3-5 persons gather around each table and first every participant thinks about a concept or content on their own, without any talking. The next step is to write down the ideas, answers etc. on the prepared place mat (= flip chart paper in the middle) on their own personal spot. The middle section of the place mat stays empty. Then the ideas are shared with the other participants on the table which are summarized in a consensus of ideas and written in the middle section of the place mat. The final step is the presentation of the idea to the plenum. This method is recommendable if there are participants that are not fond of presenting ideas in front of everybody or if very different participants and opinions are to be expected, because they have to discuss in small groups and have to find a common solution. The place-mat method can be used in different stages of a LL process. In the beginning to set a common ground, in the middle to transform previous content into a concept and at the end for a review. (Humber College, 2020)

Workshops: Design Thinking

The main focus of the Design Thinking method is the user itself. It is an iterative process which means that it is repeating itself over and over again. The ideas gathered from the Design Thinking process are also questioned regularly and changed accordingly. The six process steps consist of:

- Understanding
- Observing
- Defining viewpoint
- Finding ideas
- Developing prototypes
- Testing



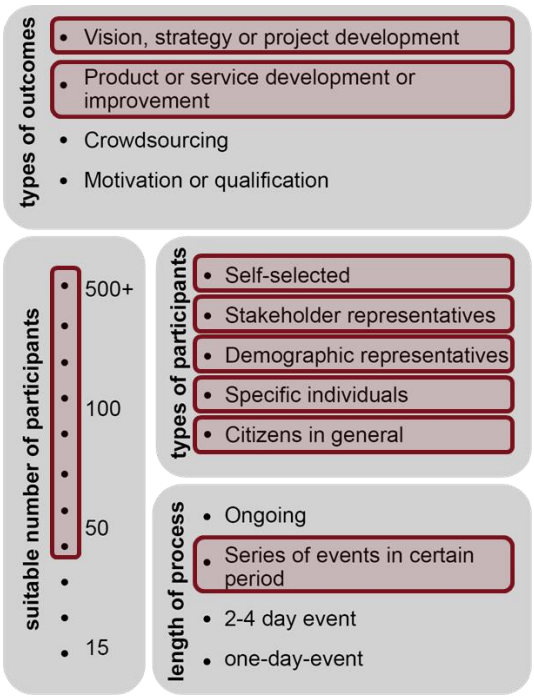
Design Thinking works with personas (= fictional representatives of users with needs and opinions towards a specific topic or product). This makes the process of understanding easier for the people involved and enables them to put themselves more easily in the users' starting position. In this way it is actually possible to achieve an innovative and user-oriented solution.

The aim of design thinking is to formulate an innovative idea that satisfies the respective target group, is technically feasible and is realistic in regard of financial aspects. Participants who take part in Design Thinking are not bound to any specific characteristics. The more colorful the group, the better is the outcome. This is the only way to ensure that different perspectives are taken into account when formulating the approach to a solution. (Enera, 2020)

Workshops: Collaborative Business Model

The open innovation concept of the "Collaborative Business Model" (CBM) is organized as a network of different stakeholders. The aim is to develop business model with the inputs of an external network as a source of innovation. The stakeholder group consists of representatives from science, industry as well as the public sector and society. A mutual understanding of the topic is an essential part of the methods. Often, there are deadlocks occurring in implementation phases of products or services that can be dissolved and sustainable results can be achieved. The CBM is suitable for economic and social development challenges on a local or regional level. Especially those, who require cooperation and are of a complex nature. Within the CBM three main phases can be identified:

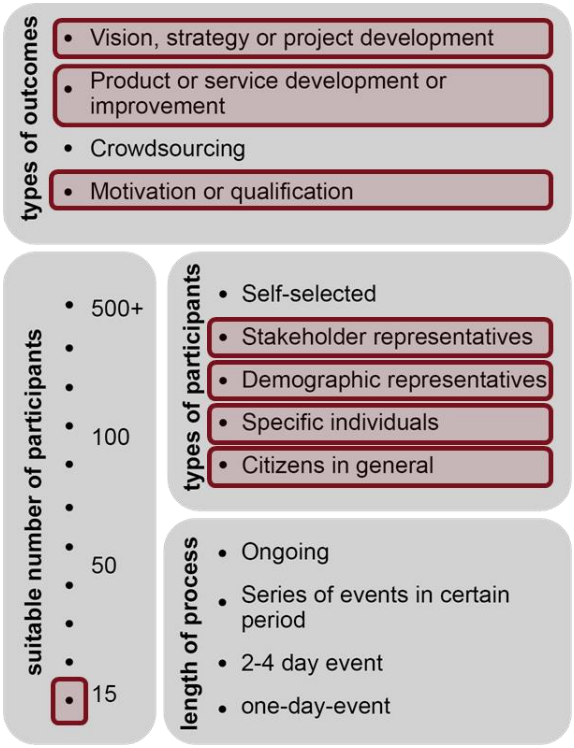
- **Pre-CBM phase:** preparation of the upcoming events (approx. duration of 3 months)
- **CBM implementation phase:** management of collaboration networks which are part in the design, stakeholder groups meet at formal events with the purpose to co-design a model, several repetitions of the stage are probably needed until results for CBM are satisfying, considered as most complex phase, it can consist of the following events: informative student – university meetings, civil society informative event, industry-student meeting, all stakeholders meeting (approx. duration of 3-9 months)
- **Post-CBM phase:** presentation to the CBM community and dissemination activities



The main advantage of the model is the input of a wide range of participants with the help of the Quadruple Helix (see page 14) network for useful inputs. This contributes to the quality of the final product or service as specificities of all parties involved are considered. (Solutions, 2017)

Workshops: Six Thinking Hats

Based on the concept of Dr. Edward de Bono, the "Six Thinking Hats" serve to apply different ways of thinking in a group to solve problems and to do so consciously. In this process, six approaches are considered with metaphorical hats:

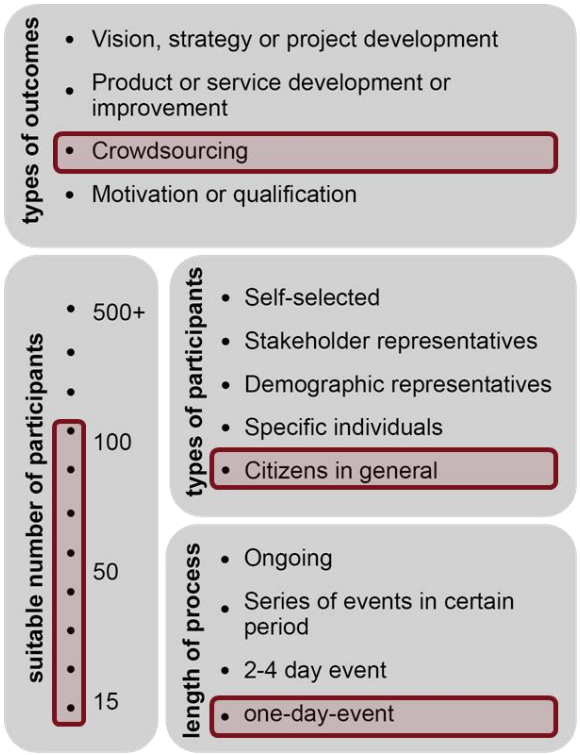


- **White:** neutral view, what information and facts are available, what do we know about the problem, what do we still need to know, what do we need?
- **Red:** feelings, how do we feel, what feelings are evoked? what is the gut feeling, what does intuition say?
- **Black:** caution, what is the legal situation, are there ethical or other obstacles? what is the worst case?
- **Yellow:** optimism, what are the advantages, what are the profits and added values, what is positive overall, what is the best case?
- **Green:** growth, what are new ideas in problem solving, new ways, new methods and options? what innovations and developments result from these?
- **Blue:** organization, how can the process be controlled, what is the roadmap, how is the whole process monitored, controlled and planned? what can be concluded from this in the end?

This method needs a very good moderation to distribute the hats accordingly and motivate the participants to add new perspectives (Waack, 2019). The method of the Six Thinking Hats is enhancing productive collaboration and helps to avoid counterproductive interaction or behavior. Furthermore, it enables to focus on dynamic and results oriented meeting and motivates the participants to be part of this process. It also gives the opportunity for a different perspective of problems (The de Bono Group, 2020).

Very similar to the Six Thinking Hats is the Walt Disney method, whereas the hats get replaced by the roles of the dreamer, the realist and the critic. (Salzburg Research, 2020)

Town hall meetings (Citizen dialogue)



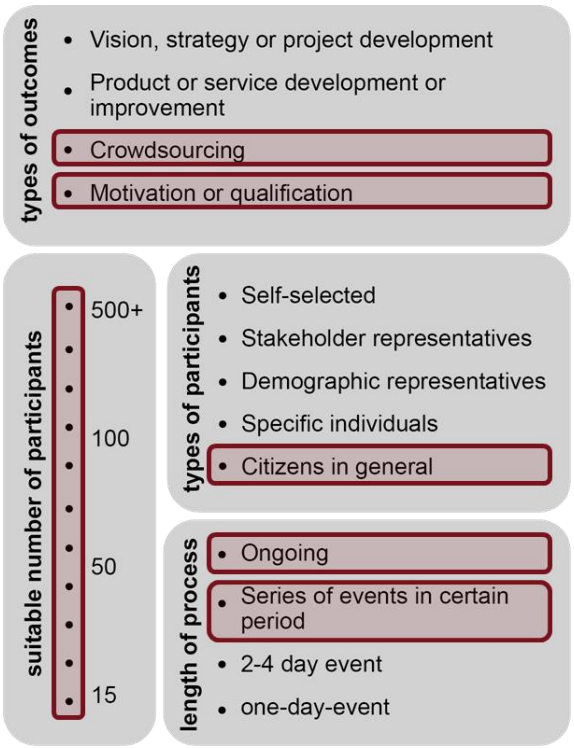
The participants of town hall meetings are both citizens and officials, giving everyone a chance to talk face-to-face in a relaxed environment about topics of a broader interest. Usually, the organization and leadership are minimal, encouraging people to settle their differences on friendly terms supported by other participants.

Given the name the method of town hall meetings is often used by politicians to inform people about a certain issue and to give them the opportunity for discussion. Nevertheless, it can also be useful for companies or organizations as it indicates interest on a specific topic and enables direct contact with citizens or users. A town hall meeting doesn't need a stringent structure but usually the person (the officials) answering the questions is sitting in front facing the group of participants. Latter can ask questions or arise issues and the officials and other members of the group may respond.

A town hall meeting has the opportunity to gather around a lot of different people with different backgrounds. Hence, a variety of perspectives and issues is brought to the table. It is also possible to get an impression about tacit knowledge and power structures in a community. (wiseGEEK, 2020)

Digital Tools

Digital tools are a method to gain a lot of inputs from participants and algorithms that help to identify commonalities among them. It is also useful to participate remotely or anonymously. Online portals and mobile applications are a form of digital tools that can use a simple language to publish electronic participation mechanisms and communicate results. There is a variety of opportunities like open forums, online events or chats used by the participants to communicate their concerns or opinions. Also, polling functions or crowdsourcing can be implemented in a digital tool to ensure the direct involvement of participants. Online surveys can help to collect participants views on a topic and can be supplemented by e-mail and phone to get more feedback (ParlAmericas).



An example for a digital tool has been set by the SINTEG project "Enera". An app has been developed to localize the personal energy demand in a household. Besides the energy demand, the app also shows savings in form of energy and money. Single electronics can be tracked for their energy demand and a connection of more households is possible. The users of the app are also supported with recommendations on energy savings and can take part in an energy saving challenge. (Enera, 2020)

7. Examples of Living Labs

In the following chapter different examples of LL are described. It does not claim to be exhaustive as already many different LL all over the world exist. Instead, the collection aims to show the diversity of LL and to give an overview of heterogeneous LL with different topics and conducted in different countries.

ENERA

enera is one out of 5 showcases of the German SINTEG program aiming for implementing digital solutions to realize the German energy transition. Enera is located in the north-west of Lower Saxony where a lot of energy is produced from wind power. Thus, the share of renewable energy in electricity generation accounts for 235%. In situations with a lot of wind and sun, the energy grid is at its limits and valuable renewable energy sources have to be locked down. For preventing this case, enera tested how the electricity grid and markets, storage, communication and consumption technologies can all be combined with one another using digital technologies. Digitalization and flexibilization are seen as key solutions for a successful energy transition.

Showcase within funding programme "Smart Energy Showcase - Digital Agenda for the Energy Transition" (SINTEG)

test how digitalization and flexibility in the north-western region of Germany can be increased for a better integration of RES (esp. wind energy).

project coordinator: EWE AG (energy provider), 32 partners from enterprise and scientific institutes including Enercon, Landkreis Aurich, Siemens, Jacobs University etc.

- Increase transparency to offer users a real-time a real time integration to the energy system and encourage them to be active supporters of the energy revolution
- Hardware upgrade (smart meter, smart transformer stations, electricity storage) and digital platform
- Barcamps to create and collect ideas
- Community challenge: App for collecting points through saving energy for becoming the "Stromsparmeister

In enera over 30,000 smart electricity meters in households, businesses and companies are installed and around 1,000 nodes in the electricity grid are equipped with digital measuring technology. This aims for a smart energy system which automatically directs electricity to wherever it is needed. Besides smart technologies, a large hybrid electricity storage with a total capacity of seven megawatts is installed in Varel as an additional flexibility option for the interim storage of wind energy.[3] Data from the smart measurements and control technologies flow onto a big data platform which provides services that are easy to use, such as a billing system and

[3] https://projekt-enera.de/blog/der-hybrid-grossspeicher-in-varel-einfach-erklaert/

reporting. The aim is to ensure that the platform is actively used for example for managing own consumption in accordance with the supply situation.

Additional to technological innovations, a further aim of the enera project was to develop new smart processes, services and products that unleash the economic potential of the energy transition. On the one hand enera established a network of electricity producers, traders and grid operators to create regional virtual power plants which trade regional energy products and services across a marketplace. On the other hand, customers were attracted to the project with innovative approaches. With the help of an interactive app households had the chance to save energy and offer flexibility e.g by charging their e-car at times with a lot of renewable energy. The households got rewarded for reducing the burden on the grid. Another app was developed for municipalities for making the energy demand of public buildings more transparent.

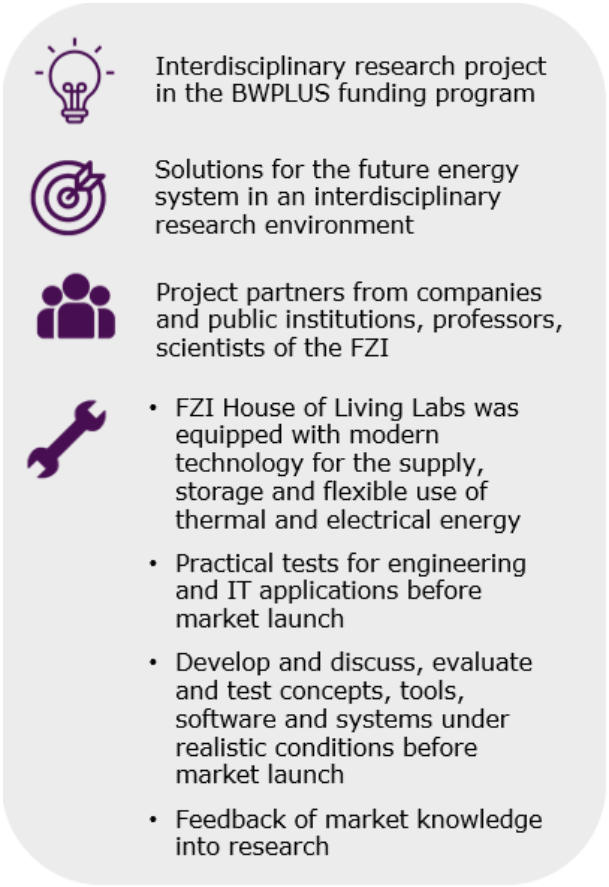
A very innovative participatory approach applied were the barcamps. As described on page 32, a barcamp is an open format where all kind of interested people come together and discuss issues which are relevant to them. Networking, learning and knowledge exchange are in the foreground. Agenda and topics are developed on the first day together with the participants and not beforehand. The missing top-topic allowed a coming together of people with very different background and energy knowledge. That could be used for getting feedback and user input from population groups beside the "usual suspects".

For bringing the issue closer to the people very innovative approaches have been applied: community challenge and barcamps.

INFO: The "Smart Energy Showcase - Digital Agenda for the Energy Transition", in short SINTEG, is a German funding programme with the aim to create transferable model solutions for a secure, economical and environmentally friendly energy supply. The program strives for temporarily 100% electrical energy provided by renewable energy sources. The five showcases (C/sells, enera, DESIGNETZ, WindNODE, NEW 4.0) develop and demonstrate digital solutions for the energy transition in large-scale model regions in Germany (e.g. digital market platforms for energy exchange, smart control technology in manufacturing companies). SINTEG is addressing the technical, business-related and legal challenges. (BMWi, 2020)

House of Living labs – smartenergy

The research center for information technology (Forschungszentrum für Informationstechnologie, FZI) in the region of Karlsruhe developed the FZI House of LL on a size of 200 m^2 with the possibility of interdisciplinary research and development by small and medium enterprises. The FZI House of LL is a platform to discover new technologies in every way that is needed before it achieves its market readiness, including exchange and generation of ideas, development, integration, investigation and testing. There are several LL where each stand for a specific topic e.g. automotive, smart home, service robotics or smart energy. The development, test and preparation for the market are accompanied by researchers of the FZI as well as stakeholders from economy, science and society. The phase of so-called real-life scenarios includes the participatory approach in an integrated research environment. New scenarios are created based on the input of different disciplines. (FZI, 2020)



One particular FZI LL is focused on "smartEnergy" and therefore the energy system of the future with modern technology for decentralized energy generation, storage and flexible consumption of electrical and thermal energy. The use of renewable energy in the smartEnergy LL is an essential part and especially the need for balancing of the power supply and demand in the grid. Hence, ICT-based solutions are developed and demonstrated reach the following goals:

- Use of consumer and producer flexibility to efficiently control energy flows in buildings
- Collection and aggregation of electrical and thermal energy demand in the building, availability of regenerative energy in the power grid, decentralized provision and on time- and load-variable tariffs for efficient control of energy flows
- Practical set up of energy management systems (incl. system architectures, algorithms, infrastructural components)

- Enhance stability and reliability of the future energy system with appropriate interfaces

The FZI House of LL smartEnergy already cooperated with several projects e.g. beegy (energy management gateway for electrical flexibility in buildings), C/sells (utilization of flexible devices), grid-control (energy management system together with project partners). Within the project an energy management panel has been developed which is able to visualize the energy flows in the building and serves as interaction interface between the energy management system and the user. (FZI, 2020)

LiLa Walldorf

The German city Walldorf implemented a LL within the research project "LiLaWalldorf". The LL investigates how a larger proportion of renewable energies can be incorporated into the electricity grid in the future. It is a three-year joint project of beegy GmbH, Stadtwerke Walldorf GmbH & Co. KG, MVV Energie AG, the Karlsruhe Institute of Technology, the FZI Research Centre for Information Technology and KEO GmbH funded by the "Ministry for the Environment, Climate and Energy of the State of Baden-Württemberg". There are 40 pilot households and 5 enterprises in the south of Walldorf connected to each other in a smart way with the aim to test the future of a decentralized power supply from renewable energies. The households are equipped with their own energy generation plants (e.g. heat pumps, photovoltaic systems, combined heat and power plants) and an energy storage for the community. If a household produces surplus electricity, it is available to the community in form of an energy pool. This way LiLa Walldorf establishes an active community of electricity producers and consumers, who exchange experiences and energy with each other. The project offers the citizens of Walldorf long-term added value in terms of living comfort and sustainability. It also includes the development of software for the control and optimization of virtual power plants and their individual components. Furthermore, the project simulates new electricity market rules and tests new approaches to billing and market regulation, which are

incorporated into energy-economic modelling. In the end suggestions to the regulatory authorities and the legislator on how a regulatory framework could support the objectives of energy system transformation are provided. (beegy GmbH, 2020)

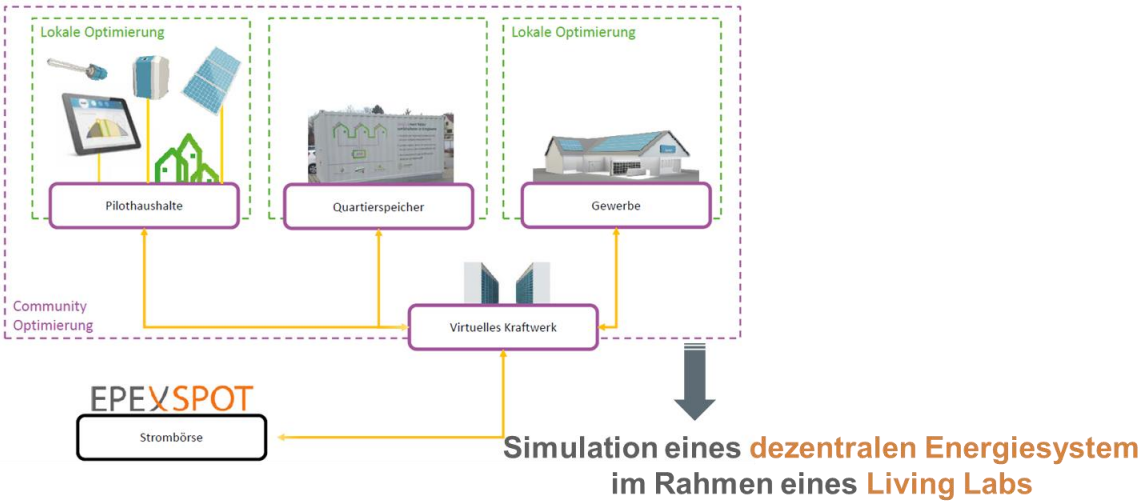


Figure 18: Structure of decentral energy system within the project LiLa Walldorf (beegy GmbH, 2020)

The opinions and experiences of the participants are a central component of the project. In the field test the participants are integrated into the project through workshops and surveys. The benefits for the participants are transparency about their energy consumption and energy production with the help of an app. All expenses and investments are covered by the project. The applied methods to involve the participants in the LL are so called regulars' tables, web app, surveys, information events and two citizen forums. The core elements of LiLaWalldorf is the sustainability aspect communicated to the participants and the added value in the community itself. (beegy GmbH, 2020)

There was a socio-scientific monitoring of the project and especially of the field test. In qualitative group discussions, the experiences before the project start and during the field test were examined. The thematic focus of this phase was the observation of the attitudes and behavior of the participants. The quantitative survey has been carried out with a focus on energy management systems, data access and time-variable tariffs. During the process of implementation and installation of hardware and software for the field tests in Walldorf valuable insights were collected. These insights include the practical requirements, obstacles and their possible solutions.

After the project end recommendations for action were derived from the results and prepared for politicians, i.e. legislators and government authorities as well as for energy industry, associations and plant manufacturers. (Steuer, Ried, Hans, Gruber, & Himmelsbach, 2019)

LiLa4green

A LL with focus on urban green is the Vienna based project "LiLa4Green". The aim of the lab is finding solutions in regard of climate change, resilience and sustainability in the urban context with an intense collaboration with citizens and stakeholders. Different topics are taken into account in the ecological, economic, social, technical and spatial context. The focus lies on smart user participation with the help of innovative methods and digital tools. Together with the participants of the LL measures of green-blue infrastructure should be discussed and implemented consensually. Awareness rising within the public for mitigation and adaptation measures in regard of climate change is a main task in the project. (Tötzer, et al., 2019)

In the beginning a design process has been executed to set the direction of the project (with goals, practical understanding, key questions etc.) as well as a screening of suitable participatory methods. Several Workshops with citizens and stakeholders have been held including three "Green-Workshops" so far. One important aspect at the start of the project was to clarify what the stakeholders can contribute and of what they can benefit within the project to ensure mutual benefits. For the motivation of citizens to take part in the "Green-Workshops" on-the-street activation has been performed, e.g. temporary spaces for conversations including game-like activities to connect with people walking by. A measurement that has already been implemented is a green parklet[4], which was decided upon in a "Green-Workshop" by the participants in form of a vote on several models. Within the project an augmented reality tool has been developed for a better visualization of possible opportunities in climate change adaptation. (Tötzer, et al., 2019) Within the project an Augmented-Reality Tool (AR-Tool) has been developed in form of an App. Users can view the AR model of a greening measure superimposed on the real physical location.

[4] A parklet is a public street furniture on or alongside a pavement and can also be a replacement for a parking space.

The project is still on-going, but main findings have already been published and include the following aspects:

- Continuity, co-decision-making and setting concrete actions (LL need some time to be established and first results as well as the opportunity for participants to decide and co-create in regard of measures)
- professional accompanying process (guiding structure and profession management is needed to keep process flexible and for knowledge transfer, in the project of LiLa4Green one partner is responsible solely for the LL process)
- low-threshold level (on-the-street activities ad mobilizing effect of other participants and stakeholders is a key to success in getting more citizens involved in the LL process, another pull-factor is the opportunity of co-creating and co-deciding)
- different approaches and sources (need for heterogeneity in the process with the help of different methods, especially face-to-face communication and information material and as used in the LiLa4Green project a smart tool in form of Augmented reality). (Tötzer, et al., 2019)

Resilience Lab in Carnisse, Rotterdam

Drawing from a longitudinal case study research, we contend that urban living labs can connect a sense of change (transformation) with a sense of place by co-creating new narratives of place, by co-producing knowledge on new practices and new relations between people and place, and by allowing the co-design or (re)establishment of places with symbolic meaning. As such, urban living labs facilitate urban sustainability transitions. (Frantzeskaki, van Steenbergen, & Stedman, 2018)

Innovation project supported by Zuid Werkt! National Programme and EU FP7-Incontext Programme

Social innovation to identify and promote personal responsibility in the neighborhood

Project partners: Rotterdam Vakmanstad', Creatief Beheer , Bureau Frontlijn, Dutch Research Institute for Transitions (DRIFT), residents, district & local organizations etc.

- Social, economic and environmental resilience
- Focus on sustainability instead of profitability
- Topics: Living together in the neighborhood, involvement in public space, craftsmanship through education, self-organizing neighborhood network
- Applied methods: workshops, participant observation, interviews

The Resilience Lab in the district of Carnisse in the city of Rotterdam is a social innovation project to identify and promote personal responsibility and self-organization in the neighbourhood. This should be reached by improving social ownership, local craftsmanship and cohesion between the citizens and stakeholders. The background of the team lies in research, education and social initiatives. They are working with various stakeholders like citizens, local organizations and district partners.

The Resilience Lab is focusing on the three fields of social, economic and environmental resilience always with the orientation on sustainability rather than profitability. The main goal was to add a greater societal value to the different measurements taken especially in vulnerable districts. Different topics are approached, this are some examples (DRIFT, 2020):

- Living together in the neighborhood
- Involvement in public space
- Craftsmanship through education
- Self-organizing neighborhood network

Different activities have been implemented like gardening in the public space, coaching for families or mobilization of local communities via future envisioning of the neighborhood. First the project team had to overcome some challenges in activating of the participants. It has to be proved that citizens and stakeholders can gain something from the LL, which required an initial analysis of the dynamics in the neighborhood and communication

activities but also showing results to local communities (Frantzeskaki, van Steenbergen, & Stedman, 2018).

The methods applied are workshops with citizens and stakeholders, participant observation and interviews. A major part was the development of a guidance tool for self-organization which aims for the connection of active people (e.g. citizens, entrepreneurs, organizations, policymakers) with each another. After the connection succeeded the plan is to develop a consensual strategy and to start implementing innovative measurements. The variety of roles in the project and the project team has been evaluated (DRIFT, 2020). Four different types of actors have been identified:

- consortium of Resilience Lab
- participants of the LL (e.g. volunteers, children, families, teachers, citizens)
- neighborhood professionals (e.g. welfare workers, civil servants, policy makers, youth coaches, social workers, urban experts and professionals)
- local actors from other districts

The clarification of the four types was helpful to understand the different perspectives in the sense of place meanings. The aim of connecting target groups was most successful when it was accompanied by physical activities and people could meet in person and interact with each other. The outcomes did not only include professional relationships but also personal ones. (Frantzeskaki, van Steenbergen, & Stedman, 2018)

Future everything/ PuBliC living lab

Initially a festival Future everything became an innovation lab and a cultural agency. Combining digital culture, art and participation the organization wants to jointly generate new ideas for the future. The empowerment of citizens, communities and project partners in a collaborative way is the main goal of Future everything. The regularly held festival is a platform to engage with citizens in form of the Future lab. Different methodologies are in use like cultural events, community forums, participatory design or practical workshops. The main topic is art that is transferred in other non-art domains and opportunities in combination with technology are raised. (FutureEverything, 2020)

Smart Energy Showcases – Digital Agenda for the Energy Transition through cellular, participatory and diverse energy networks, funded by BMWi

empower citizens, communities and project partners to create new ideas for the future with the help of art, technology and collaboration

57 partners from science, industry and network operation

- Combination of research, participatory design and public art commissioning
- Living Lab is part of a festival with the following methodologies in use: cultural events, community forums, participatory design or practical workshops
- Different topics at every festival, e.g. PuBliC Living Lab that tries to develop a platform to combine people, bicycles and cars

The Future lab within the Future Everything Festival in Manchester in 2015 had the topic of developing a model for public engagement during the festival itself including the exploration of specific research questions. A two-day workshop was held with the core aspect of collectively writing a full conference paper as an output of the workshop. This approach allows to collect theoretical, methodological, qualitative and quantitative data as well as findings and reflections of the workshop. The authors of the paper have been the investigatory team (e.g. academic researchers) and the ten workshop participants. The main task of the participants was to borrow a bicycle to cycle through the city of Manchester and answer to structured and unstructured research questions about future cycling in the city. Smartphones have been installed to the bicycles with a software to collect comments in text format, pictures and GPS data. Hence, the participants took part in the LL both as subjects delivering quantitative data and co-authors of the final paper. The outcomes have been presented at the end of the day in form of the paper to a panel consisting of the team of authors and various stakeholders coming from the Manchester cycling culture. Also, feedback on how the results can influence the perception of data, identity and movement across the city of Manchester have been collected. The participants should have the opportunity to take part in the whole research process within the Lab in an active way. The methodology used can be summarizes as participatory research, action research and live blogging. This way of mixed methods provided the chance to collect data of multiple stakeholder that would find its way to the paper. It also

helped to prevent the previous assumption of the data, that is usually part of a research. This Future Lab has been an experiment on how to execute public engagement and transparency with the collective writing of the paper. (Maxwell, Mehrpouya, Speed, & Monsen, 2015)

The Festival Lab originates from PuBliC LL that tries to combine people, bicycles and cars within a platform. The platform offers citizens the opportunity to create a strategy to share, play, communicate and travel within this mobility microcosmos. It strongly encourages the communication and connection of members of the platform which should then result in networking social/transport practices. (Maxwell, Mehrpouya, Speed, & Monsen, 2015)

PROLIDA

The research unit "Active and assisted living" of the University for Applied Sciences Carinthia developed the Living Lab PROLIDA which is short for **Pro**fessional **L**iving, **I**nnovation and **D**evelopment Lab for an **A**geing Society. It includes the research and development of a user centered participation within a multidisciplinary environment with the focus region of Carinthia. (FH Kärnten, 2020) The topics of interest are technological innovations as part of an active and healthy lifestyle as well as formal and informal care services. In general, holistic approaches in the fields of health and wellbeing (AAL/AHA) are reflected in the LL processes. Within the Lab quadruple-helix stakeholders (social providers, entrepreneurs, SMEs, industry) are brought together and supported in testing innovative solutions within a multi-disciplinary group including end users. The aim is to provide modular, effective and near-to-the-market solutions fitting in to individual use cases. The basic principles are (Oberzaucher, 2020):

- Co-Creation: actively involving users and focusing on their needs, diverse stakeholders etc.
- Multistage-Evaluation: knowledge transfer, efficiency to cost and benefit, usability and acceptance, innovation life cycle
- Real-Life-Settings: business models, ecosystem anchoring strategies, ethics

PROLIDA is a combination of infrastructure, methods and processes and actors in a quadruple helix framework. The research unit fully integrates the LL approach in their research and for innovation development. The first step is the idea & conceptualization followed by implementation and evaluation. The final step is exploitation and anchoring (FH Kärnten, 2020). A great importance of the LL is anchoring the results of the processes and adding benefits to the various stakeholder participations. It has already been seen that several outcomes from end-user groups in different projects are implemented in regional health and care strategies. Further benefits for different stakeholders are:

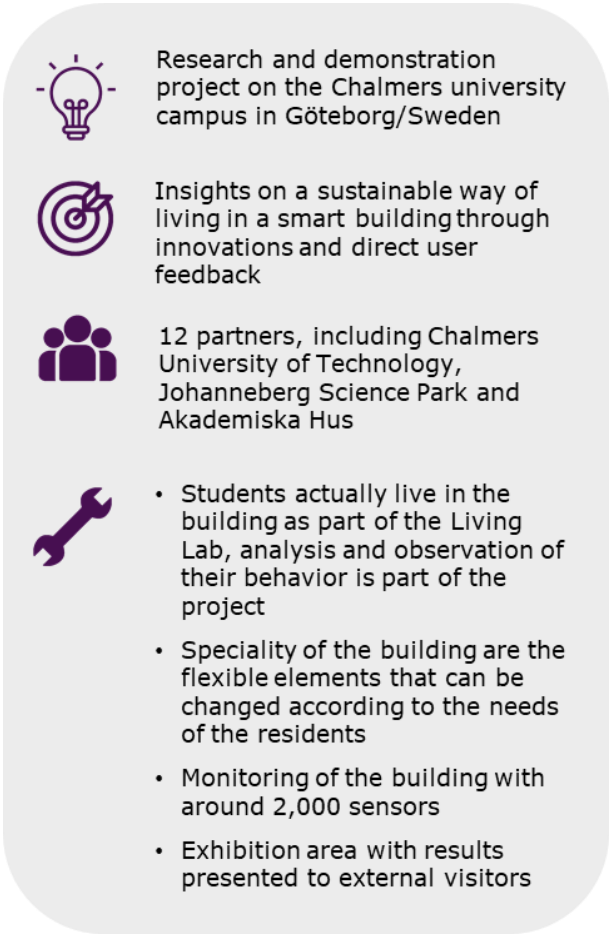
- Policy-makers: proofed concepts for new strategies; transparency of results; democratic, citizen-science-based approach;

- Involved companies: clear, thematic focus; quadruple-helix network (formation of sub-eco-systems); expectations and direct knowledge from policy-makers, clear need definition; validation and evaluation; accompanying, multi-disciplinary research activities offered by PROLIDA
- Research: secondary research opportunities for a long-term perspective; realization of complex, multimodal co-design, evaluation and socio-economic-anchoring strategies; infrastructure, recruiting, ethical guidance, logistic-planning and research support is offered by PROLIDA; quadruple-helix network and cooperation with various partners on different levels

PROLIDA has discovered the need for a heterogenous and large user pool with diverse trial-user-groups and non-overlapping trial-participants. The lab therefore plans to involve up to 1,000 users into the LL processes within the next 5 years to support different projects. This will be realized with the help of regional policy-makers and involving the already implemented, regional strategy of "Health and Wellbeing". Also, infrastructure has to be improved by implementing different semi-lab situations. An example is the involvement of dementia patients of a senior-citizen center. PROLIDA is also cooperating with strategic partners on international level. (Oberzaucher, 2020)

Another important part is the use of a multi-method approach to ensure knowledge transfer, intervention evidence and participative development from which diverse stakeholders are benefitting in future decisions. There is a concrete example for intervention evidence where 70 older users with chronical conditions were part of a Health Coach Service including a telemonitoring technology. During a time period of 16 months health and medical experts did interventions with the participants resulting in a better awareness and compliance of the participants health and new diagnoses, which then could be treated in early stages. Also, regional policy-makers benefitted from the novel interventions for future payment perspectives. End-users are also high beneficiaries of this LL approach. This is due to the direct involvement and co-development processes in the different phases of need definition, concept development and implementation and evaluation and the link to the daily life needs of the participants. Another benefit is the role of participants as early-adopters of new technologies and hence, rather low entry-prices. (Oberzaucher, 2020)

HSB Living Lab



The HSB Living Lab is experimenting with a sustainable lifestyle in the building environment. Innovate solutions should be developed and the knowledge gained during the process is used to raise the quality of homes and buildings (HSB Living Lab, 2020). The "Lab" is a building on the campus of Chalmers University of Technology in Gothenburg, Sweden. It can accommodate 40 students and guest researchers in 29 apartments and offers a prototyping/co-creation lab that can be used by partner organizations and external stakeholders (463m^2 in total). There are also common ground floor spaces for public and private use (Hagy, Bard, Sasic Kalagasidis, Sredanovic, & Camarasa, 2017). Students will actually live there during the LL process, which offers the possibility to interact with them and observe their behavior. Those results are collected on a small scale but it's a representation of reality. The specialty of the building is the possibility to change different elements, e.g. the façade can be replaced to test different materials. The project is running for 10 years and hence, various short- and long-term research projects will be executed within the HSB Living Lab. One activity is the monitoring of around 2,000 sensors, installed in the apartments to measure different data like wall plug electricity consumption, tab hot water consumption or in-wall temperature. The tenants have the possibility to tailor the performance of the buildings systems.

The results based on different research activities are presented in the exhibition areas directly located in the building. This way, the awareness of sustainable solutions in buildings can be triggered and everybody with an interest in the topic has access to the exhibition. It is also possible to download an audio guide to give visitors the possibility to stroll through the building and get information. The results, most probably products and services, will further be used for building and refurbishing accommodation in the future. The consortium of HSB Living Lab counts 12 partners, including Chalmers University of Technology, Johanneberg Science Park and Akademiska Hus. (HSB Living Lab, 2020)

An evaluation of the project has shown that it has to include the participants of the LL not only as testers and evaluators but as co-creators to enhance open innovation. This could be achieved by a common communication channel to activate participants and built up connections. Furthermore, a process to collect and implement project ideas from the participants is recommended. In general, it is possible for internal and external stakeholders as well es the residents of the building to propose project ideas. (Hagy, Bard, Sasic Kalagasidis, Sredanovic, & Camarasa, 2017)

Other Living Labs

As can be seen from the previous examples there is a large variety of LL around the world. Here are some more examples to illustrate this fact:

Green Village

The Green Village, located on the TU Delft Campus, is aiming for radical innovation in the build environment with sustainable energy technology (e.g. robot arm as a test lab for unmanned automatic charging, building materials from waste). A development area is transformed into an entrepreneurial environment, supporting cooperation between universities, industry and external stakeholders. An experimental environment gives the opportunity to develop, test and demonstrate innovations embedded in a LL format with participants from the public and government. Methods used are co-creation workshops, challenges and discovery days. People are actually living in the Green Village and it can be visited by the public via walking and cycling routes. (TU Delft, 2020) (Hagy, Bard, Sasic Kalagasidis, Sredanovic, & Camarasa, 2017)

Future Classroom Lab

Based in Brussels, the Future Classroom Lab represents an inspirational learning environment that opens new perspectives of the role of pedagogy as well as technology and design in classrooms. There are six different learning zones open to visitors, each with a certain topic like students' and teachers' skills and roles, learning styles or societal trends affecting education. The project team exists of the European Schoolnet, 34 supporting Ministries of Education, ICT providers working together with other stakeholders like policy-makers, industry and teachers. The methods used are face-to-face training workshops and strategic seminars to bring together the different stakeholders and develop visions for the future classroom. (Future Classroom Lab, 2020)

MAPUTO Living Lab

The MAPUTO Living Lab (MLL) is very intensely involving the local community to generate project ideas and set up a compact end-user group for the outcomes of the lab. It is located in a developing region in Mozambique with the aim to promote local entrepreneurship and to help the execution of innovative projects for a better quality of life. Project ideas are digital platforms in eHealth or eGovernment including different stakeholders, especially local ones from the municipality, hospital or citizen groups. The lab is working together with LL from Europe and wants to build up a close collaboration and networks nationally and internationally. One activity is the implementation of a marketplace of needs, competences and ideas in the field of ICT. Summer Schools of ICTs are planned involving SMEs and educational institutions. (ICT4G, 2020)

Apulian ICT Living Lab

Together with local business a variety of user-driven technological solutions where developed in the Apulian ICT Living Lab. The open innovation approach supported SMEs to create solutions for public-sector requirements. The Lab focused on domain specific innovation with prosumers acting in open innovation environments with real-life conditions. Developers and customers worked side-by-side in the sense of co-creation to meet actual market needs while the development phase. Hence, several services and products were co-designed, tested and validated to later on draft business models for a possible future marketing. An example is a tourism platform promoting the regional tourism and cultural attraction developed in the Apulian Tourism Lab. It can be incorporated into marketing initiatives and includes 'off-the-beaten-track' attractions, suggested itineraries and information on local artisan manufacturers. (European Commission, 2018)

8. Conclusion

A LL is a very flexible, open-minded and interactive way to innovate in a real-life context and to include users in the development and implementation of new ideas, transitional processes or innovative products. The key factor is the real-life setting which requires collaboration in an intersectoral and interdisciplinary consortium and which places the user itself in the middle of a LL.

This implies that users are not only considered in every different phase of a project or product development but that they are an active part in it, which means that a comprehensive understanding of the framework and the product is requested from them. Furthermore, with the valuable feedback and inputs from the users there is a higher chance that the development or product will succeed in a satisfactory way for all stakeholders involved.

In transitional processes such as energy transition user participation is crucial to embed the change process into the local structures, behavior patterns and daily life. If technological and organizational innovations do not fit the needs of the users, they will not reach the users and will not establish themselves in the long run. LL should help to avoid this by involving users right from the start. The local or personal knowledge is highly appreciated and complements the knowledge of research experts in a very useful and sustainable way. The deep interaction with the so called "real- world" is opening more insights and results than the theoretical development with simulations etc. in a closed laboratory, respectively it complements theoretically viable solutions with practical experiences. This is particularly important if the topic is complex and fast-moving such as digitalization.

No LL is like the other, they differentiate according to the stakeholders involved, the environment or the product itself. Hence, it is of high importance to organize a LL in a very individual way with specific methods fitting the needs of the users and the project. The difficulties occurring with various stakeholders having different interests can be overcome with a foresighted approach of choosing methods and stakeholders. The organization of a LL needs a deep understanding of the framework and the microcosmos where the LL is taking place. Methods like Stakeholder Mapping help to name specific persons that can for example have a positive or negative influence on future implementation processes. If they are identified in an early stage they can be motivated to take part in a LL according to their interests. If there is a huge variety of stakeholders with strong personalities in a LL, the Six Thinking Hats method can bring a different perspective to each participant and facilitates finding a common solution. Also, unforeseen challenges can arise and despite of a comprehensive preparation new methods have to be applied in a short time. An example is the Covid-19 pandemic, when suddenly no physical meetings could happen. Instead, digital tools where used by different LL to keep up the exchange and even work on new

ideas with participants. Even though it seems to be a suitable method, the organizers of the LL have to keep in mind that digital tools may not be used by specific participants (e.g. older people, people without access to digital tools). In this case, it has to be ensured that inclusion must still be maintained and therefore, other methods have to be added. In general, a LL certainly needs a lot of preparation and has to be evaluated and rearranged during the LL process. The chosen examples of LL around the world show that this concept can be applied to different settings and there is already a big collection of individual projects to look after and to learn from them. The better the preparation of a LL and the adaptation to the individual situation the higher the chance of success.

A huge advantage of the very intensive process of a LL is the fact that it doesn't end when it's finished but it can be the start for a new development or project. This is due to the intensive (local) knowledge and lessons learned but especially due to the network built up during the LL. The interactions with various stakeholders lead to familiarity and trust towards the LL experts and new opportunities for collaboration may arise in the future.

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10. Figures