Establishing a sustainable living lab

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I. INTRODUCTION AND CONTEXT

About ACSELL

The primary objective of the ACSELL project is to sensitize SMEs and policy makers towards the living lab approach in order to improve innovative capacities of SMEs. For SMEs, living labs can play a key role in the demand-driven innovation process since they integrate a variety of (potential) users into the innovation process (ideally) right from the beginning. Consequently, they can explore and discover new use cases and revenue models and minimize risk. The living lab approach allows

1) a better understanding of the actual demands and needs of end users;
2) a better match of demand and supply and;
3) an increase in efficiency and effectiveness of the innovation process.

This approach will not only inspire policy makers to apply a similar collaborative approach in developing policy, but also help them better understand the innovation process as such. In this way, policy decision-makers will be able to provide better framework conditions inter alia to SMEs. Within the ACSELL project, several partners are considering integrating the development of a living lab in their policy instrument.

ACSELL pilot action

Living labs constitute a combination of methodologies, infrastructures and a way of working in an innovation process. With a better understanding of governance, methodologies and functioning of living labs, the overall process of effective demand-driven and open innovation can be improved. By the recognition that there is a need for a structural and governance change, a broader, yet step-by-step set of changes can be accelerated in a collaborative and transparent

process. SMEs greatly benefit from being able to experiment in the safety of specific infrastructures to optimize their products and services in collaboration with relevant stakeholders, primarily also with potential end users (Ballon et al., 2018). Therefore, ACSELL partners CEI (Central European Initiative, Friuli Venezia Giulia, Italy), EKUT (Eberhard Karls Universität Tübingen, Baden Württemberg, Germany) and Thomas More – LiCalab (Living and Care lab, Flanders, Belgium) worked together in a pilot action to share expertise and work in a real living lab use case in order to adequately provide optimal framework conditions for innovation policies, specifically for the health and care sector.

In this pilot action, the partners conducted network building workshops with the local health and care ecosystem of stakeholders and implemented and tested two living lab methodologies based on the real needs of one selected SME case. In this document, the three parties share results, materials and methods with the full consortium of ACSELL partners and with a wider audience of stakeholders interested in open innovation ecosystems. More specifically, the expertise and experience will be shared on 1) building a local network and 2) methodologies on co-creation (collaborative development of a new value) and testing of a real product with a human factor study, the analysis of human abilities and limitations with respect to a product. The valuable experiences gained in the pilot action will directly flow into the establishment of a living lab on the topic of health and care in the respective regions.

About the partners of the ACSELL pilot action

CEI (Central European Initiative) is a regional intergovernmental forum of 17 Member States in Central, Eastern and South-Eastern Europe. It fosters European integration and sustainable development through regional cooperation. CEI work is focused on achieving two main goals: Green Growth & Just Societies.

In the ACSELL project CEI focused on two objectives to support the Friuli Venezia region in fostering demand-driven open innovation within the healthcare system:

1) Strengthening research, technological development and innovation;
2) Improving access, use and quality of ICT.

In this framework priorities of investment and specific objectives are: to promote business investments in R&D by developing links and synergies between companies, research and development centers and the higher education sector, in particular for the development of products and services, technology transfer, social innovation, applications in public services; to support demand-driven innovation, networks, clusters and open innovation; to increase business innovation activities.

EKUT (**Eberhard Karls Universität Tübingen**) is the lead partner of the ACSELL-project. Founded in 1477, the University of Tübingen can look back on more than 500 years of tradition. As part of the university, the LebensPhasenHaus (LPH) [House for the Phases of Life] is a transfer facility and innovation infrastructure; it is a place for research, for demonstration and for knowledge transfer and as such is a competence center on the topic of independent living and aging in place. The LPH inter alia sees itself as a hub for a so-called quadruple helix ecosystem in order to orchestrate the exchange of knowledge between business, research, administration and citizens. Accordingly, the LPH has a broad network and access to a multitude and diversity of stakeholders in the state of Baden Württemberg to ensure effective and cross-sectoral dialogue, knowledge transfer and is thus very interested in fostering multi-stakeholder, integrative and collaborative engagement in living lab activities (ranging from ideation and co-creation to subject recruitment, testing and communication of research results).

LiCalab (Living & Care lab) is a mature living lab performing user design research and offering living lab services to the health and care sector. Founded in 2012, LiCalab is familiar with the challenges that go along with the setup of a living lab and brought in its expertise in the ACSELL project and in the pilot action as advisory partner.
LiCalab provided advice and coaching to all other partners, based on its hands-on experience, in:
- Creating concrete policy measures that support SMEs;
- Setting up living labs as innovation support instruments for SMEs and facilitators for open innovation and collaboration between different sectors (research, SME, users, …);
- Giving insights in concrete barriers that SMEs run into when innovating;
- Setting up local innovation ecosystems or clusters as an engine for innovation in regions;
- Connecting ACSELL to the European Network of Living Labs.

Since 2019, LiCalab is an expertise center of the Thomas More University of Applied Sciences.

II. LIVING LABS AND LIVING LAB METHODS

Living labs and the living lab approach

Living labs have been recognized as an innovation instrument in European policy for a number of years. An official recognition came with the establishment of ENoLL (European Network of Living Labs) under the Finnish Presidency of the European Union in 2006. Since then, living labs have been seen as pillars of the European Research, Development & Innovation system. The living lab movement is fully synchronized with the policy of the European Commission and integrated into the 'Europe 2020 strategy' and the 'Digital Agenda for Europe'.

Living Labs or the living lab approach, as a user-centered, open innovation ecosystem based on a systemic user co-creation approach tends to be difficult to grasp. It generally does not help that there are indeed very different living lab formats and settings, ranging from co-creation workshops as a methodology to entire cities functioning as a space for data collection or testing. Moreover, the term itself suggests a lab-like infrastructure, while one key feature is the systematic testing in real life settings.

We refer to ENoLL that describes living labs as '*Open innovation systems, based on a systematic user co-creation approach, that integrates research and innovation activities in communities, placing citizens at the center of innovation.*'

"Since then, living labs have been seen as pillars of the European Research, Development & Innovation system."

People can be involved in all phases of a *design thinking process* for innovation thanks to living lab methods: from idea generation to building prototypes, from design to commercialization.

Living labs have a lot in common:

- A multi-stakeholder, end-user driven innovation approach;
- use of the methodology of co-creation with, for and by end users to design innovative solutions;
- conducting real-life experiments to shorten the time from research and product design to market;
- active local innovation ecosystems in which local living labs bring together local needs and challenges and scientific and technological knowhow;
- a role as orchestrator, matchmaker and facilitator to effectively bridge the innovation, skills and investment gap;
- the capacity and methodologies to orchestrate co-innovation and experimentation processes, assess the solutions' impact and create future business and value models.
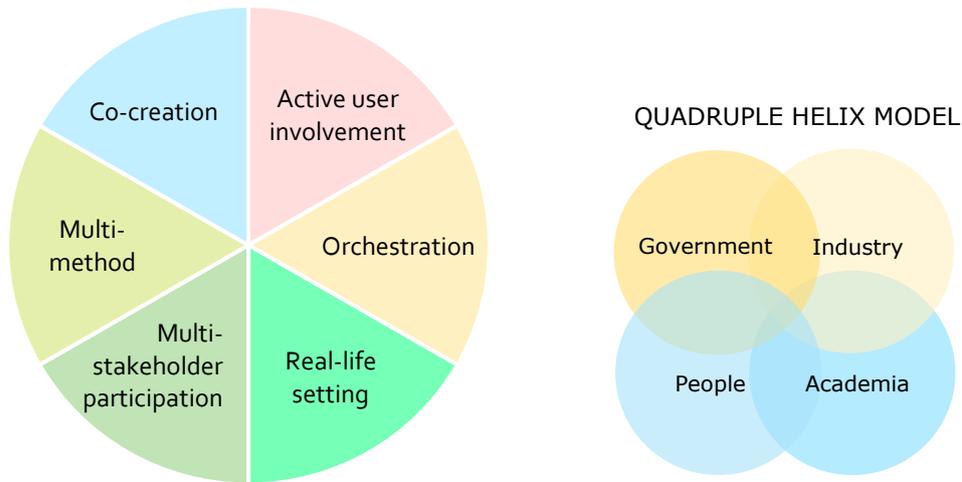
Figure 1 What living labs have in common (source ENoLL)

New concepts, products, services or processes in the various innovation phases – from exploration and ideation to development, prototyping, testing and market entry – need different methods, infrastructures and actors involved. For setting up a living lab or an open innovation ecosystem, it is on the one hand essential to have access to a trusted network of stakeholders, and on the other hand have a profound expertise of living lab methods and methodologies.

Although living labs have common characteristics, thematic areas, hosting organizations, actual living lab environments, target groups, types of activities and services may be different. Living labs for health & wellbeing and social innovation represent an important percentage of living labs (cf. numbers ENoLL)
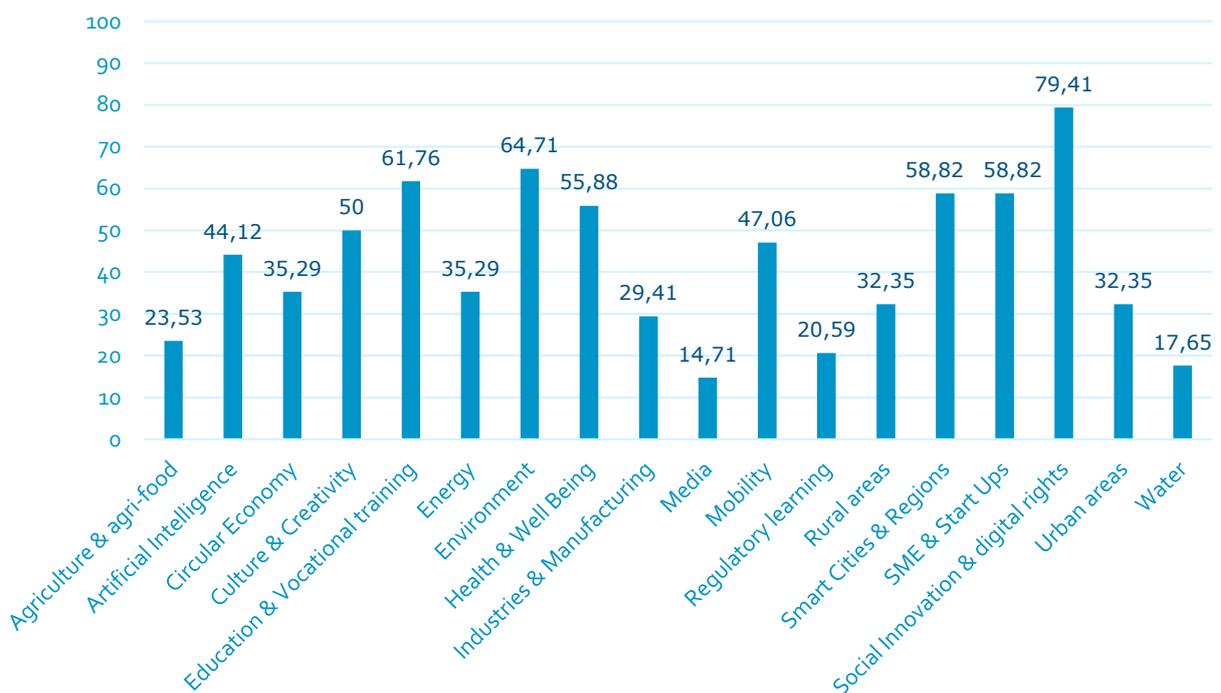
Figure 2 Areas of work of living labs (source ENoLL)

Living lab approach as a leverage for successful innovations

A big number of innovations do not have the expected success because the product/service does not respond to the needs or to the user context (Cantamessa et al., 2018). This is why more companies and organisations want to involve end users in their development process more intensively.

Involving end users is necessary (Ballon et al., 2018), but access to end users is not always easy. You need the right connections, know the right channels and use adjusted methodologies to successfully succeed in co-creation and testing with end users. Also, involving end users means that there is an important increase of information to be evaluated, an increased complexity of project coordination and a partial control loss on market strategy and planning. Confidentiality and intellectual property issues may complicate the management of projects.

At the same time the health sector presents extra challenges such as country-specific regulations and third party payer insurance systems, which can be different between countries. A lot of stakeholders can be involved, a.o. formal and informal caregivers, healthy citizens, patients, elderly, insurance companies, distributors…. And many questions arise: how can you 'unlock' reimbursement, which co-payments are possible, under which conditions can solutions be marketed, which doctors to target, what are country-specific targets and the resulting business models…? This means that mapping of stakeholders and users is important to understand how to find the right information, partners and customers to build the business model (Albert & Van der Auwermeulen, 2017).

An impact study on living lab approach for SMEs (Ballon et al., 2018) showed that most companies adapted their product prior to market launch based on insights generated by Living Lab activities. Their knowledge and competence level were raised, and the results helped to persuade internal/external stakeholders to continue development and/or financing.

> *"Most companies adapted their product prior to market launch based on insights generated by Living Lab activities."*

Why do companies participate in living lab projects?

From a qualitative business survey conducted within the framework of the Interreg project CrossCare SMEs indicate that the top 5 most valued services from living labs are

1) selection and recruitment of end users;
2) development and testing of the innovation with end users;
3) the role as a matchmaker;
4) methodological support during the innovation process and;
5) access to specific scientific expertise.

Challenges for living labs

The growing importance of living labs is reflected in the number of living lab environments being set up. There are a few general challenges for living labs:

- Living labs are often set up on a project basis. This means that these living labs cease to exist once the project ends. As a result, a lot of effort, expertise and knowledge that was built up is lost.
- Living labs are sometimes initiated by one particular industry partner that strongly promotes its own research agenda or its own technology. This limits the possibility of open innovation.
- Partly because of this, we see that not all stakeholders are included or represented within a living lab. Within an Open Innovation model, the objective is precisely to involve all stakeholders in the development process.
- Living labs often have a local and small-scale scope. Applying scalability is a challenge but in order to appeal to innovative companies of a bigger scale, living labs need to cooperate at a national and international level.
- Tools to support research within a living lab are not always available. This is most evident in the lack of monitoring tools to measure impact.

The journey of LiCalab

LiCalab originated in 2012 out of an exercise to scope the content of a new urban neighborhood within the city of Turnhout. Before starting up, a feasibility study was conducted. Based on the results, a framework for the living lab and the LiCalab ecosystem was defined and the contextual preconditions were analyzed. A proposal for an organizational and operational structure and a concrete action plan for the further development was set up.

To check the feasibility, LiCalab mapped the local/regional support and potential for innovation in living and care and then discussed the **preconditions** focusing on the financial preconditions on the one hand and the governance model on the other. This resulted in (critical) success factors like the need for structural input from partners - both financially and on content -, funding mechanisms and organizational structure.

The core elements of the feasibility study are displayed in Table 1.

LiCalab received funding from the Flemish government between 2013 and 2016 to start the living lab operations, to gain expertise through funded living lab projects and to build the user panel. Since 2019, LiCalab is a separate expertise center (research group) at the Thomas More University of Applied Sciences.

LiCalab collaborates with and/or delivers services for profit and social profit companies and organizations, local and regional authorities, care organizations and research institutes, both on a regional and a European level. Its user panel has grown until +1.300 participants between 2012 and 2022. LiCalab has a strategic plan with clear key performance indicators that is followed up closely to evaluate quality management and general performance.

Table 1 Core elements of feasibility study LiCalab

1/ REGIONAL SCAN	2/ STRATEGIC PLAN	3/ IMPLEMENTATION
• Define regional needs • Describe innovation potential • Environmental factors • External developments • Stakeholder mapping	• Level of ambition • Focus & type of activities • Governance model • Operational model • Spatial and functional development including infrastructure • Financial resources	• Action plan and actions

Roadmap to establish a sustainable living lab

While setting up a living lab, a few elements are key. Both the living lab networks ENoLL and EITHealth/Ulabs define key elements that are crucial for sustainability and quality of a living lab.

EITHealth/Ulabs developed a **Self Assessment Tool** for living labs that assesses the following key parameters:

- Management & governance
- Finances & HR Resources
- A clear strategy and value proposition defining mission statement, vision and goals
- The approach to involve end users in real life dimensions
- Well documented operational processes
- Quality management & monitoring (outcomes and impact)
- Expertise of living lab methods and methodologies

ENoLL mentions similar criteria that are being evaluated while applying to become a member of the network. The **complete manual with application guidelines** can be consulted on the ENoLL website (ENoLL, 2022).

Feasibility study

Before establishing a living lab, an exploratory phase is required. In this exploratory phase, a feasibility study can offer insights in the viability of the living lab. Besides an analysis of the regional needs, this study can also explore if the forementioned parameters can be sustainably defined and installed in the future living lab. It is important to have core actors on board and to be sure that the living lab can survive in the long term.

In order to valorize innovative solutions, the living lab calls on the expertise and commitment of its core partners (see Figure 3).

1. Define the living lab ecosystem

First, a start is made to define the **living lab ecosystem** and map possible core partners, supporting partners and users/clients of the lab. The ecosystem or value chain of the living lab can be defined as a user-driven open-innovation cooperation between actors from four groups of core partners.

Public, social and societal actors (i.e. public authorities, health care providers, health insurance funds, …)

Economic actors (i.e. companies, SMEs, large corporations, private health care providers, insurance companies, etc.)

Public

Private

People

Knowledge & Capabilities

•End users (i.e. citizens, carers, health professionals…)

•Knowledge institutions and research centres (universities, colleges, R&D departments of companies, expertise centres…)
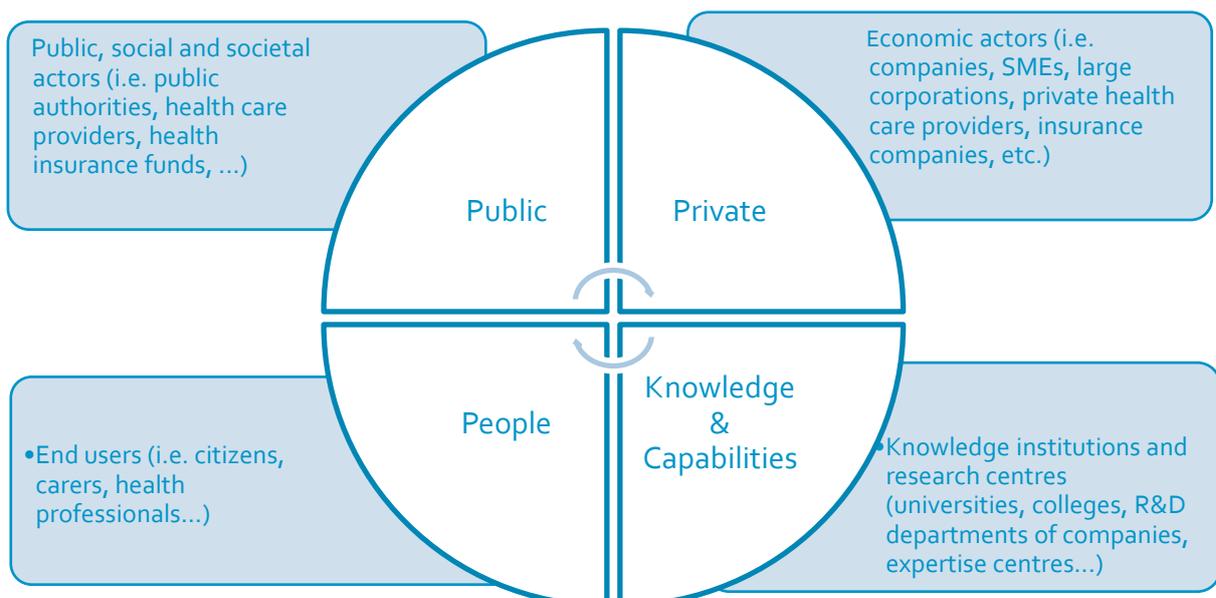
Figure 3 The living lab ecosystem: four groups of core partners

2. Co-create a strong strategic plan with stakeholders

Once the feasibility study has defined the ecosystem and the preconditions to establish the living lab, it is important to co-create a strong strategic plan with stakeholders in which the building blocks, as shown in figure 4, need to be considered.

This exercise defines the concept and the framework of the living lab. This includes the establishment of a mission statement, the description of both strategic and operational objectives, the spearheads, scope and focus of the living lab and its future core activities. Also, infrastructure and location must be considered in the development of the living lab.

This process could include following steps

A. Stakeholder mapping with power-interest grid. Through stakeholder mapping the most important stakeholders and their interests can be defined. How can they help shape and/or support the living lab and where are the critical points? The stakeholder mapping shows to what extent the type of stakeholder is important based on interest and influence. This includes stakeholders from both internal and external groups and possible intermediaries.

B. Conduct stakeholder surveys

C. Organize co-creation workshops with a limited group of core actors in a first phase and a wider group of stakeholders (believers) in a second phase. Together, mission statement, vision, activities and priorities of the living lab can be defined and linked with the strategic priorities of the region.

3. Define organizational structure

Living lab management requires different complementary roles and expertise. Within LiCalab, we have defined dedicated roles for operational management (1), business development (1), panel & community management (2), project management (2) and user design research (2).
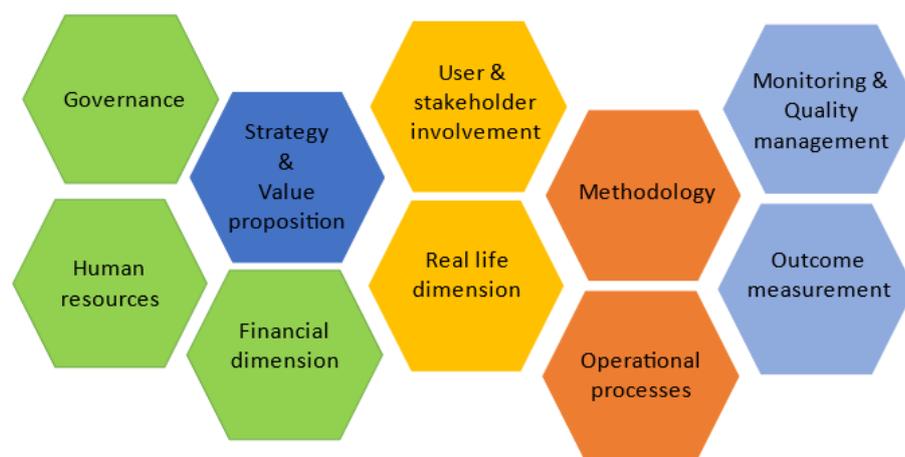
Source: EITHealth/Ulabs

Figure 4 Building blocks for co-creating a strategic plan with stakeholders

Building the network

Develop the network to stimulate open innovation

A prerequisite for facilitating research, development and innovation in a living lab is the creation of an 'open innovation environment' in which relevant actors from the value chain (companies, knowledge institutions, care actors and (local) governments) work together and in which people in their role of citizen, care recipient, informal caregiver, care provider… are actively involved in the innovation process. In cooperation with key actors of the value chain, the living lab can set up an open innovation platform for health & care, where representatives from the quadruple helix can meet. Stimulating and bringing together the various parties from the care ecosystem and supporting user-driven open-innovation partnerships is one of the core objectives of the living lab.

Initiate collaborative open innovation projects

A good way to start working as a living lab is initiate, support and supervise concrete open innovation projects. Through the ACSELL pilot action, the partners from CEI and EKUT have experienced the opportunity to run a living lab project and be acquainted with living lab operations and methodology. Through the execution of real use cases, the living lab builds a portfolio of representative projects that showcase the activities and added value of the living lab.

It also gives the opportunity to build a community of people interested to participate in living lab projects, to collect data and to offer access to infrastructure.

Consequently, the living lab ensures that various parties are brought together and supported to collaborate in innovation projects in health and care.

In addition, the living lab can offer the necessary support in defining open-innovation cooperation projects, elaborating and realizing them.

The living lab facilitates access to a test panel and to real life-test environments and infrastructures.

Building the user panel

Test panel

While setting up a community living lab, the development of a large-scale panel of test users as part of the living community within a defined area is an intensive, but necessary action. This community forms a large-scale test environment of persons willing to test certain products and services in their own homes, and, for this also want to use their own infrastructure and/or have certain infrastructure installed in their homes by the living lab.

This user panel fulfills two core functions.

- Firstly, the panel is needed as a recruitment (data)base for the various experiments/research projects (as well as facilitating scalability) that will run within the living lab. The panel must be very well profiled and easily accessible, so that it can be activated quickly.
- Secondly, this test panel aims to act as a benchmark for the living lab. It is the breeding ground from which specific needs and requirements but also certain trends can be identified bottom-up. This information can serve as a basis for defining new projects.

The test panel should be large enough to

(1) have a good reference group that is representative;
(2) have enough critical mass to recruit and activate in a fast and efficient way;
(3) facilitate the scalability that certain projects require and finally,
(4) generate qualitative, reliable and correct results.

The panel can be built incrementally based on the needs of new projects. However, it is strongly recommended to set up a generic panel in parallel from within the living lab itself. Test persons should be willing to cooperate on a regular basis in experiments/research projects of the living lab.The test panel may not be a dormant panel, but a panel that, preferably on the long term, commits to actively participate in the living lab activities.

Calls to participate in projects are directly addressed to the own user panel. But you can also reach out to care organisations, patient organisations and senior associations, and to local communities from your network. Social media channels and personal networks are also part of an effective recruitment strategy.

The panel community is the engine of the living lab. In order to guarantee the involvement of the end users, whether these or citizens, independent care professionals or care facilities like hospitals, residential care homes or home care organisations, a relation of trust has to be built. LiCalab regularly organises social networking activities to keep the panel updated on the results of projects and share information on new developments within health and care. LiCalab sends out a monthly newsletter.

LiCalab has two dedicated panel managers. They are the single point of contact for the user panel. Panel managers know how to address the user panel and how to support them during the living lab activities. They are the face of the living lab for the panel members. This is important to keep the community alive and responsive and to build trust.

Figure 5 shows the coherence of the living lab community ecosystem. There is an **active panel** of members who are regularly involved in projects or living lab activities. Depending on the topic, the profile of the target group and the nature and intensity of the activity, panel members sign in for a specific project/ activity.

For diversification and to avoid bias, a larger group of potential candidates has to be in place. This **community of interest** must be kept informed and activated. Even if one cannot participate in a particular project, it is important to let them feel part of the living lab community.

The **platform panel** is the network of care professionals, patient organisations, local authorities...They reach out to their own members/citizens or participate in projects.

The **external panel** is a professional network that is called upon for its own specific expertise. For specific projects with specific target groups, we look for experts, intermediaries who can make the bridge.

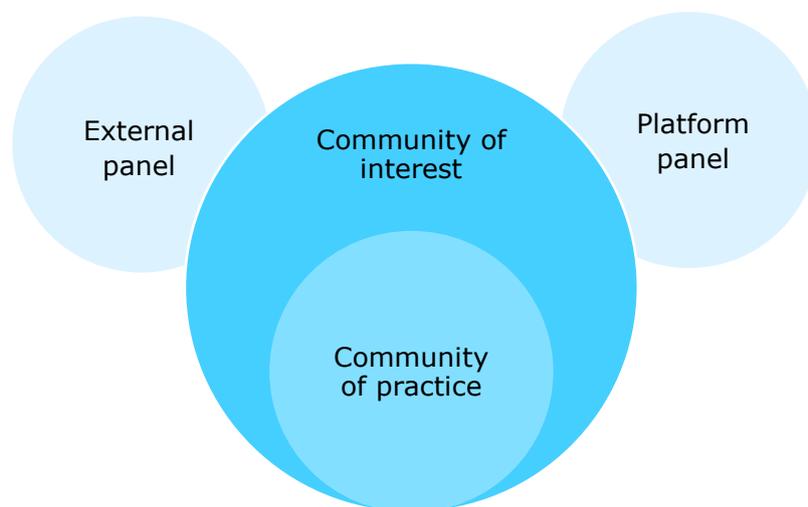*Figure 5* The coherence of the living lab community ecosystem

- Community of practice = actively involved in projects, field trials
- Community of interest = adherent members willing to participate
- Platform panel = local authorities, health care organisations, social organisations, patient organisations, citizen initiatives/representatives
- External panel = financial organisations, academia, living labs…

Panel management and data management

Besides the set-up and the maintenance of the community, the follow-up of the project activities and the involved panelists is also key, including all ethics requirements (informed consents etc.). An important part of panel management is logging the activities, profiling the panelists, having an overview of the status and engagement of the panel and evolution (growth, diversification) of the living lab panel.Therefore a user friendly and efficient **software tool** is essential to monitor the panel and to track the panel activities.

It takes time to build a test panel and it will always be work in progress. Keep that in mind!

- Leen Broeckx, panelmanager LiCalab

The software tool (e.g. panel management tool) should include:

- an overview of panel member lists with personal data to segment and to filter
- an overview of participants per project and/or activity
- a survey tool that is connected with the panel members (unique survey links and integration of results into personal details).
- a communication tool to send out invitations, surveys... to a selected group of (potential) participants

It is difficult to find an 'all in one' software solution that meets all the needs listed above. A panel management software tool is also subject to revision, so be sure to take this along when choosing a supplier. Every 5 to 10 years you might need to change suppliers to be able to work with a more service oriented software tool.

Table 2 Learnings and challenges for panel management

> A. It takes time to build a test panel and this is a work in progress.
> B. It is important to be a trusted partner.
>   1. Ethical approach (GDPR, Informed consent, Medical-ethical approvals,..)
>   2. Provide feedback to the panel: Inform about activities before and after
>   3. Show your skills: customised work protocol during sessions and real life testings based on both scientific approaches and experience.
>   4. Take time to get to know your panel: check their intrinsic and extrinsic motivation!
> C. Your story to engage participants must be attractive: make it fun and appealing.
> D. It is a challenge to reach panel members without internet, digitals skills.
> E. It is a challenge to reach panel members from lower social classes and migration backgrounds.
> F. Although motivation for participating mostly is intrinsic, an incentive is much appreciated.

How to position the living lab

The living lab is situated in all phases of the innovation process. This means that it must be able to facilitate both the 'idea-generation process' via the capture and analysis of user data, the organization of brainstorms with test users, the gathering of various stakeholders, and the pre-commercial, market introduction process, in which services are evaluated on various dimensions.

Act as a facilitator between various actors

It is important that the living lab positions itself as a facilitator in these open innovation processes and relies on its core activities like community building, panel management, co-creation with end users and facilitating access to real life-test environments and infrastructures. Usually, the living lab itself does not focus on technology development or process innovation. It must ensure that this can happen in an environment that involves the right partners and is set up and implemented in the right way. The living lab will also have to find connections with existing local, regional and international initiatives, but also funding mechanisms.

Infrastructure of the living lab

An important part of the functioning of a living lab is the ability to offer a specific infrastructure aimed at facilitating the living lab activities. In particular, we refer to the facilitation of access to test environments where innovations can be experimented within realistic circumstances in the daily living and working context of real users on the one hand, and the facilitation of (longitudinal) data monitoring on the other. The living lab infrastructure can be situated in a specific building or environment, but can also be deployable at other locations (f.i. within the city, in hospitals, care centers, and in the houses of the community of end users).

Table 3 The position of a living lab

What is a living lab NOT?	How to position a living lab
• technical testbed • a laboratory • closed organization • marketing instrument • limited project in time • classic network organization • purely local/regional instrument • single focus • technology provider	• facilitator • integrator • experimental environment • open innovation ecosystem • open innovation network

Positioning on local, regional and European level

Positioning on local level. On the local level we situate the operational working area of the living lab. In concrete terms, this means that experiments, recruitment of end users/test users (a.o. citizens/patients/relatives and professional care providers) take place within an identified local area. Within this local level, the living lab positions itself as a complementary party in other local initiatives. Besides this important local operational level, the living lab can also decide to have a regional and international dimension.

Positioning on the regional level. On this level, the living lab can situate the ecosystem and the 'market' of the living lab. The development of the living lab ecosystem must clearly transcend the local level and develop partnerships with nationally/internationally situated actors (both from the care sector, knowledge institutions, industry, governments). This is necessary to transcend the local level and to make the lab attractive for both national and international customers.

Positioning on a European level. At a European level, the living lab can position itself on the basis of its focus areas, the specific infrastructure, the large-scale test community and its own longitudinal projects and thus gain a competitive advantage.

Methodologies, tools and techniques

Each project is unique. The key elements of the living lab approach are 1/ co-creation with end users in a design thinking process to capture their needs and 2/ real life experiments to assess user experience, usability, user friendliness and user acceptance. Some living labs add more research specific activities to this or, at the other end of the spectrum, a more elaborated market launch support. The choice for a specific methodology depends on several parameters like innovation phase, type of innovation, end users profile…

In the process of innovation, we distinguish following phases:

1. Ideation, screening and evaluation
2. Detailed investigation (requirements, feasibility, business model)
3. Development of concepts and prototypes
4. Testing and validation
5. Market launch

| Idea, screening & evaluation | Detailed investigation | Development | Testing | Market launch |

Figure 6 Phases of the innovation process

However, this is not a linear process. Innovation is a rather complex process that starts from a fuzzy front end with a lot of information and uncertainties, that requires several iterations to come to a successful market launch and uptake. For each phase, you can find a specific scope and challenge and a hypothesis to check.

End users can be involved in each of these phases as experts of their daily life or work and provide valuable input for the development of new solutions. Involving end users is not always the easiest way as you will need to process more information and ideas may change a little or a lot. But you also may find interesting new ideas for the future.

There is a large choice of methodologies, tools and techniques that can be used for end user involvement. **Below, we describe a few common approaches.**
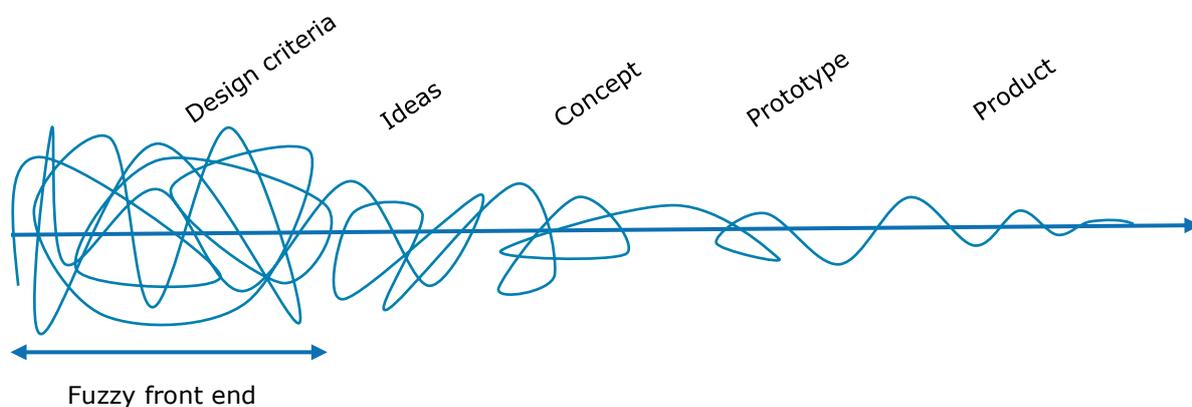
Design criteria   Ideas   Concept   Prototype   Product

Fuzzy front end

Figure 7 The process of co-design is not linear

source: Sanders & Stappers, 2013

4

Data collection

While involving end users you will gather a lot of data, both quantitative as qualitative. A few examples of data collection are:

- Automatic data collection (smart devices, digital applications, software, website…)
- Observation with specific techniques like Shadowing and Thinking Aloud exercises.
- Diary studies
- (Semi-structured) Interviews
- Surveys
- Co-creation and demo workshops

A combination of quantitative and qualitative data provides a rich data set that is useful for the development of innovations.

Exploration

The exploration phase provides a better understanding of the needs of end users. Often, the process starts with a thorough desk research to gather already available information that helps to select the right tools for further research with end users.

Additionally, surveys add both qualitative and quantitative information. What do end users think of an innovative idea? How will they use it? How much will they pay for it? What about general trends in a larger population? Conducting a survey is an appropriate research method to answer these questions with a larger group of participants.

Methodologies that are often used in the exploration phase are for instance diary studies, sensitizing probe and stakeholder mapping.

Table 4 Methodologies of the exploration phase

Method	Explanation	Example
Diary study	A diary study is a research method used to collect qualitative data about user behaviors, activities, and experiences over time. In a diary study, data is self-reported by participants longitudinally — that is, over an extended period of time that can range from a few days to even a month or longer. During the defined reporting period, study participants are asked to keep a diary and log specific information about activities being studied.	Appendix 1
Sensitizing probe or cultural probe	A sensitizing probe collects personal experiences. The participant receives a toolkit to document certain aspects of his/her life. Sensitizing probes are used in the exploratory phase to gain insights on people's thoughts and behaviors and to generate first ideas. Participants are being immersed in the topic. The gathered data help to set up and run co-creation activities.	Appendix 2
Stakeholder mapping	Stakeholder mapping is the visual process of laying out all the stakeholders of a product, project, or idea on one map. The main benefit of a stakeholder map is to get a visual representation of all the people who can influence your project and how they are connected.	Appendix 3

Co-creation

In a **co-creation process**, end users ideate and/or evaluate a new product or service. How does it fit in daily life and work? How can its development be improved? Multiple creative methodologies support the process. Users with real needs generate ideas and make them concrete. As such, solutions can be created that meet end users' needs. There are many good reference works that guide living lab researchers through the multitude of methodologies and tools.

Common methodologies that are used for co-creation are **brainstorming**, **customer journey mapping**, **empathy mapping** and **personas**.

Table 5 Reference works for methodologies and tools

www.designkit.org

www.ideo.org

www.maketools.org

toolbox.hyperisland.com

www.siscodeproject.eu/repository/areas/toolkit-for-policy-workshops

userinnovationtoolkit.ugent.be/

www.lannoo.be/nl/cecilias-keuze

www.flandersdc.be/nl/gids/tools/service-design

www.flandersdc.be/nl/gids/tools/gps

iotdesignkit.studiodott.be/

Table 6 Methodologies for co-creation

Method	Explanation	Example
Brainstorming	A method of generating ideas and sharing knowledge to solve a particular problem. Participants are encouraged to think without interruption. Brainstorming is a group activity where each participant shares his ideas as soon as they come to mind. At the conclusion of the session, ideas are categorized and ranked for follow-up action.	Appendix 4
Customer journey mapping	A tool to visualize the experience of interacting with your product or service from the user's point of view. This map is critical because it forces you to look at how your user actually experiences your service or product versus how you think they do. The customer journey map can also be used to design a new service.	Appendix 5
Empathy mapping	An empathy map is a collaborative visualization used to articulate what we know about a particular type of user. It externalizes knowledge about users in order to 1) create a shared understanding of user needs, and 2) aid in decision making.	Appendix 6
Personas	Personas are fictional characters, which are created based upon research (co-creation, interviews...) in order to represent the different user types that might use your service or product in a similar way. Creating personas helps the designer to understand users' needs, experiences, behaviors and goals. More: http://www.blueprint-personas.eu	Appendix 7

Prototyping

Prototyping is an experimental process where designers implement ideas into tangible forms from paper to digital. They build prototypes of varying degrees of fidelity to capture design concepts and test them with users. With prototypes, you can refine and validate your designs so your brand can release the right products.

Table 7 Methodologies for prototyping

Method	Explanation	Example
Mock-up or wireframes	A mock-up is in fact a model of a product. A sketch of a possible end result. End users often don't know exactly what they want, but they do have ideas. A mock-up shows what is possible, and thus makes the invisible visible. End users sit around the table and can comment on the sketch, everyone is involved in the process and in making choices.	Appendix 9
Lego Serious Play	Building quick prototypes of ideas. Using basic bricks, creative thinking is enhanced. The visual presentation contributes a complimentary understanding of the concept. Visualizing the concept into a model eliminates the fear of failure as it is treated with a prototype that can be modified during the design thinking process.	Appendix 10

Demonstration

To get an initial feedback on an existing Minimal Viable Product, a demonstration can be very efficient. You can use the MoSCoW-method to prioritize features and functionalities in Must-haves, Should-haves, Could-haves and Would-haves.

Human factor study

A human factor study is a method focusing on the interaction with a product in a challenging simulated environment with the goal of improving safety, performance and user acceptability. In one-on-one sessions participants are asked to go through specific tasks while interacting with the product. Together with observations and thinking aloud, questionnaires are used to gather mixed data.

In chapter III on the ACSELL pilot action we will give particular attention to the process of a human factor study.

"A human factor study is particular interesting when there are safety issues, like in testing medication packaging."

Real life testing

Finally, end users can be involved in **real life testing**. They evaluate the user friendliness and the applicability of innovations in their daily living and working environment. This allows to identify concrete problems and opportunities and gives insight into what goes well or not and especially why. Based on these experiences, developers can adjust the concept.

Usability test plan dashboard

When ready for a field trial, this test plan is a guide to conduct the research in a structured way. Your objectives and action plan need to be clear before you start working with real users. *See appendix 8.*

CONCLUSION

1) The living lab has to define a clear focus and identify a number of spearheads on which it should profile itself and distinguish itself from other initiatives.

2) The living lab needs a clear governance structure, a business plan and a strategic plan with clear KPIs.

3) It is important that the living lab is expanded into an open-innovation cooperation model in which public organizations, companies (including healthcare organizations), citizens and knowledge institutions are closely involved. From there, a living community must grow with a specific community-management component for the end users/residents.

4) The lab has to define its infrastructural living lab environment where innovations will be tested: hospitals, cities, care organizations, citizens' homes…

5) The living lab has to be able to facilitate projects in a fast, efficient and cost-effective way. This will require (1) the ability to formalize and replicate processes and methodologies, (2) the ability to build the panel and infrastructure in such a way that it is multi-purpose and incremental, and (3) the ability to bring the right parties together.

6) The scope and 'working area' of the living lab should be clearly defined.

III. ACSELL PILOT ACTION AND APPLIED METHODOLOGIES

Reference documents

- Template 1_Call text pilot action
- Template 2_Registration form innovation
- Template 3_Review criteria identified innovations
- Template 4_Scoring table all partners
- Template 5_Decision form partners
- Template 6_Declaration de-minimis aid
- Template 7_ Scenario co-creation sessions
- Template 8_Scenario human factor study

Description of the pilot action

Within the ACSELL pilot action, the partners (CEI, EKUT, LiCalab) conducted network building workshops with the local health and care ecosystem of stakeholders and implemented and tested two living lab methodologies based on the real needs of one selected SME case.
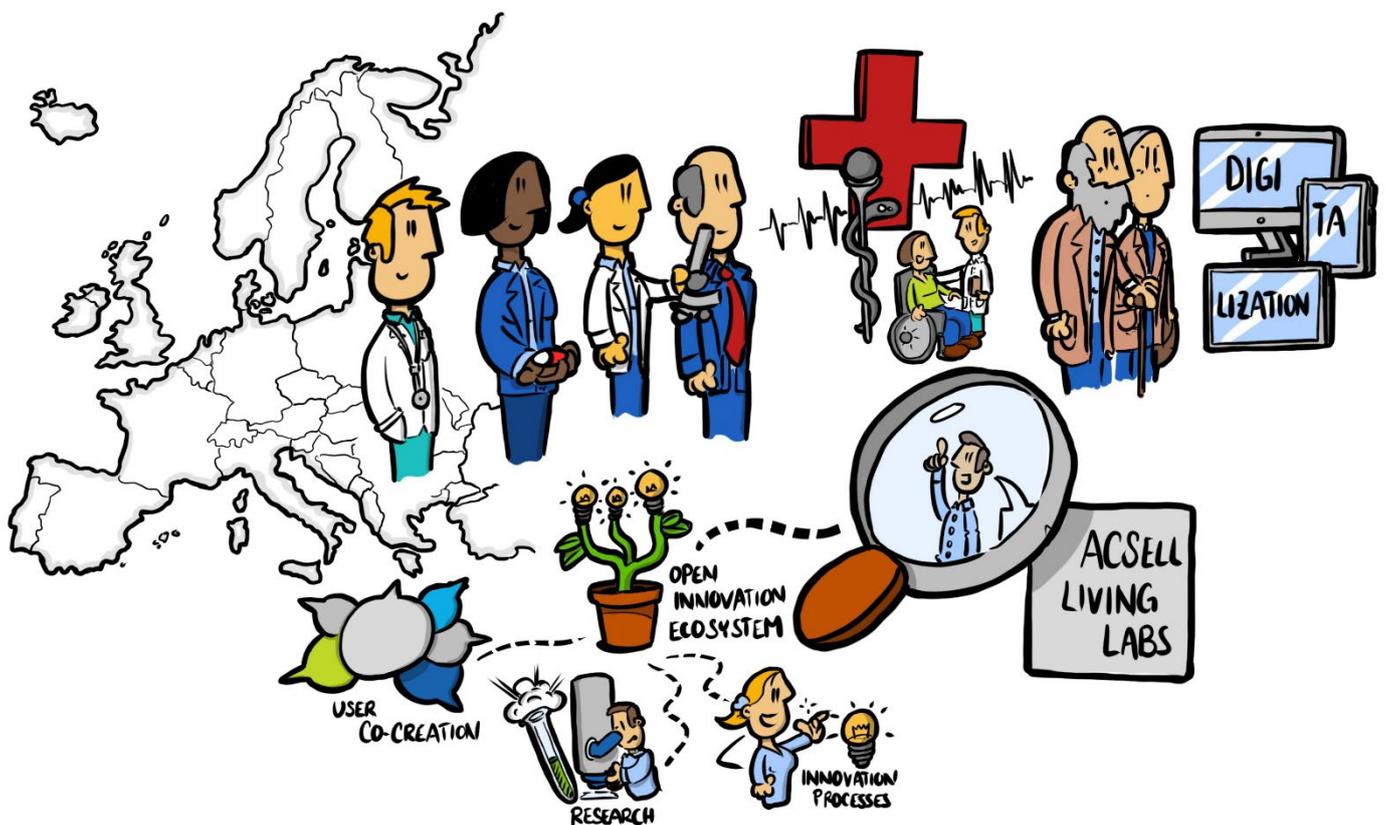
Preparation of the pilot action

In September 2021 a call was launched to apply for the pilot action. The call was communicated by all partners through their communication channels. Four SMEs applied. Each partner scored the four applications according to the following criteria:

- Social relevance (10 pt)
- Demand driven innovation value (10 pt)
- Feasibility and added value of a human factor study (10 pt)
- Benefit from services delivered by living labs (10 pt)
- Commercial feasibility of the innovation (10 pt)

The scores of all partners were discussed and evaluated in an online consortium meeting.

It was the Portuguese start-up Clynx that was selected. Clynx develops Motiphy+, a game application for remote rehabilitation exercises.

Motiphy+ is a telerehabilitation tool for exercising at home, in combination with sessions at the hospital. The physiotherapist and patient can follow-up the evolution through the online platform.

Motiphy+ consists of a camera to be attached to the computer or television screen and a software that needs to be downloaded. The software gives access to an online platform to track motions and to analyze the results of the exercises.

After the selection a kick-off was organized with Clynx to check their expectations, to discuss the proposed living lab methodologies and to set a timeline. After this kick-off, monthly online meetings were scheduled to keep the communication and engagement of all partners close.

(Image from www.clynx.io)
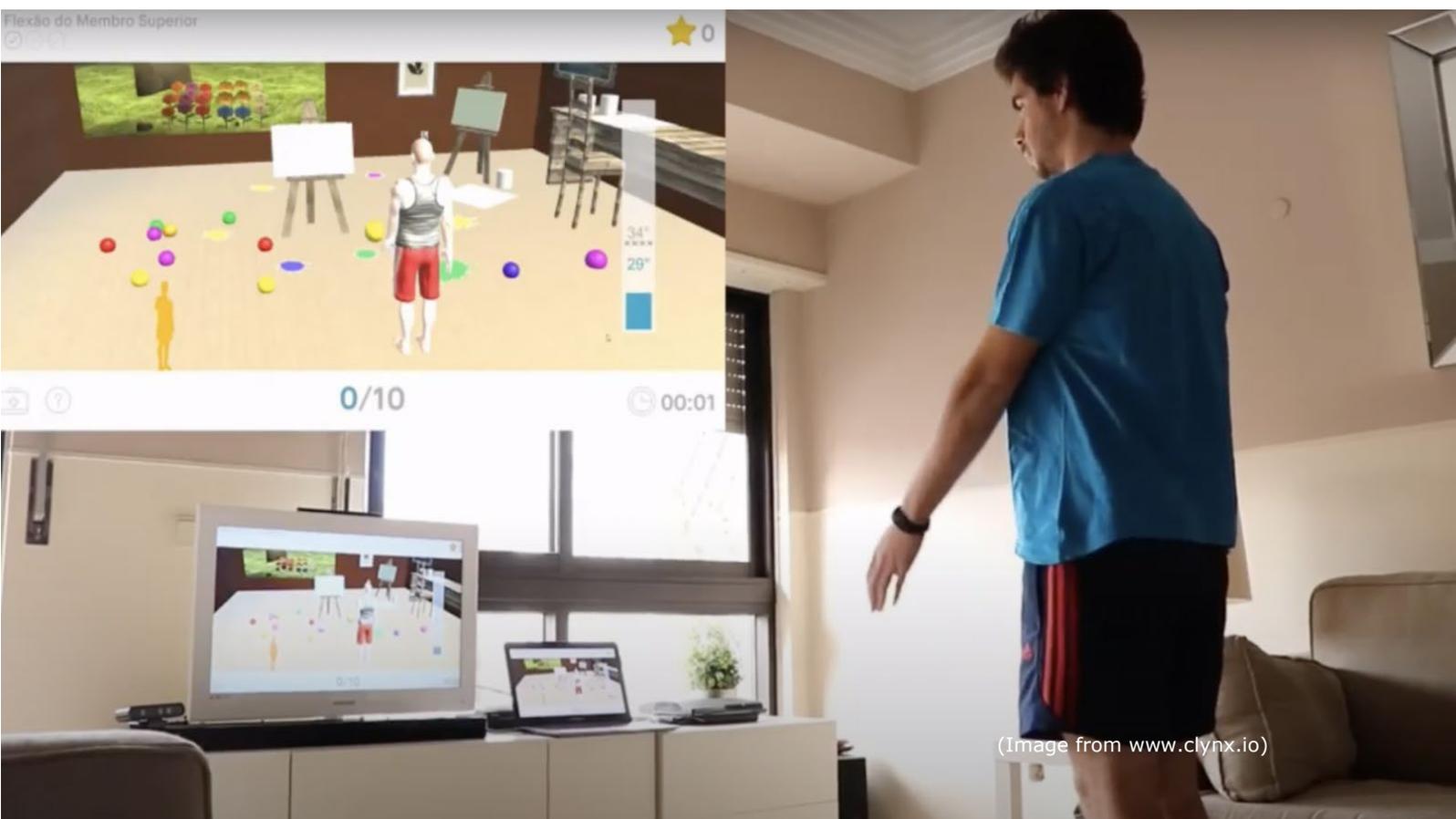
Applied methodologies

The aim of the pilot action was to transfer knowledge on methodologies and living lab activities from LiCalab to CEI and EKUT. Therefore two methodologies were chosen to experience and to learn by doing.

- Co-creation sessions with end users and care professionals
- Human Factor Study

LiCalab advised in the set-up and reporting of the activities. CEI and EKUT performed the living lab activities, reported on the co-creation sessions and the Human Factor Study. LiCalab analyzed data across the regions and made a concluding report for the Human Factor Study.

Co-creation sessions

A co-creation is a group activity where researchers and participants are equal partners. In the strict sense, co-creation is an iterative process. In practice it also has an added value in evaluating an idea or concept.

In the case of the ACSELL pilot action, the product was already developed. Therefore, a co-creation was set up as a group discussion with creative methods and techniques.

The set-up of a co-creation session contains 4 parts:

Figure 8 ACSELL | Set-up of a co-creation session

Preparation

In this phase of the process it is important to understand the product, what it does and how it works. Therefore, the start-up company provided each partner with the Motiphy+ device. Each partner could start experimenting with the device. Together with the partners and Clynx, the objectives and research questions were determined.

To avoid a medical-ethical approval (which is time and money consuming), partners chose to include only healthy individuals. The target group of care professionals was also seen in broad sense: professionals who had a view on the rehabilitation pathway. This could be a physiotherapist, an occupational therapist or staff member of a health care organization.

As far as the group size is concerned, literature indicates a minimum of 4 to 6 individuals (Guest et al., 2016). More than 10 participants is detrimental for group dynamics. It is better to interact with a smaller group of 6 to 10 people.

With the research questions and the target groups in mind, LiCalab drafted the scenario, in close collaboration with CEI and EKUT. The goal of the sessions was to gain insights into how end users and care professionals perceive this innovation and how it could fit in their daily life or workflow.

Besides the practical organization of date, time and location, the recruitment is key. Where and how to reach out to the right profiles? From the experience of LiCalab, lunch time was suggested for the co-creation session with the care professionals. A one-hour lunch meeting fits best into the professionals busy schedule.

Table 8 gives a description of the different components of the co-creation session. Every component has a specific content.

Table 8 ACSELL | Content of the co-creation session

Component	Content
Introduction	In this part the participants are welcomed and offered a drink. A warm and personal welcome creates a friendly atmosphere. Participants are asked to read and sign the informed consent. The facilitator explains the goal and set-up of the session. It is important to make time for a short introductory round so that every participants can speak up.
Context mapping	In this part the situation 'as is' is mapped. We ask open questions. Participants are encouraged to express their experiences and thoughts. Enough time has to be provided for this part. Participants need to be immersed into the topic. In a group discussion participants build further on other experiences. Real needs are being uncovered. In a co-creation session, we try to involve as many senses as possible. Not only storytelling, but also writing, drawing, making artefacts is encouraged. Working with templates or canvases is a technique to encourage participants to write down their thoughts and be more actively involved. Moreover, a template visualizes the discussion and provides a basis for the discussion. For this co-creation we used the habit analysis to gain knowledge on users' patterns, behaviors and habits. We focus on frustrations and opportunities A central timeline is drawn. Common tasks are mapped ('how do you usually…'). Below the line, frustrations or negative experiences are added for each task. Above the line, opportunities and improvements for each task are added. To map the situation 'as is', other techniques can be used, e.g. customer journey map, storyboard or observation. With the habit analysis, we have chosen a simple straightforward template that helps to structure the discussion.
Feedback on the product	In this case a product was already available. In this part we capture first impressions and evaluate the product after a demonstration. The mindmap technique helps to visualize and guide the discussion on the barriers and opportunities. To gain feedback on the product, other techniques can be used, e.g. a customer journey map (how do users experience the product in time through different touchpoints), a problem-solution matrix (to identify problems and gaps in the current product and to ideate on solutions). To measure the willingness to pay, every individual participant fills out a short survey. It is important to ask participants to do it on an individual basis to not influence each other. Afterwards a group discussion can go more in depth on the perceived value from the participants point of view.

Ideation	After evaluating the product, participants generate ideas for improvement, ideas on new features. In this case, we opted for a group discussion with some predefined questions to have variations and to keep up the tempo. For the market entry we have prepared a canvas to visualize and activate participants.
Conclusion	To conclude, the facilitator formulates the main results and thanks participants for their contribution.

Analysis

For the analysis and reporting we used a more pragmatic approach. Instead of transcription ad verbatim we opt for an intensive note-taking and abbreviated transcript during the sessions. Illuminating quotes bring the session alive. This intensive note-taking implies a dedicated note-taker. A predefined template can be helpful to structure the note. From the notes, themes and subthemes can be brought to the surface. LiCalab provided a template and the reporting of the co-creation sessions was done by CEI and EKUT.

Communication

Communication of the results is highly appreciated by participants. This has to be discussed with the company if (parts of) the report will be open access. In any case, feedback can be given to the participants on a more general level without going into detail. Participants will be engaged and motivated to participate in another activity if they know what happened with their input.

Points of attention

- Recruitment takes time and demands a personal approach.
- Time of care professionals is limited.
- End users (patients, citizens) are not always familiar with a meeting culture. Provide enough time for introduction to make them feel comfortable.
- Visual elements (templates, canvases…) keep focus in the discussion.
- Encourage participants to be open and to participate actively by writing down ideas and to speak them out.

Human factor study

A human factor study is a method focusing on the interaction with a product in a challenging simulated environment with the goal of improving safety, performance and user acceptability. In one-on-one sessions participants are asked to go through specific tasks while interacting with the product. Together with observations and thinking aloud, questionnaires are used to gather mixed data. A Human Factor study is a pre-field test that can be useful when technical difficulties are present.

The advantage of a Human Factor study is that vulnerable target groups (elderly, people with lower digital skills…) can be included because of the controlled environment and the presence of the experimenter. Although the experimenter can't deviate from text and explanation of the study design, he can support and empathize with the participant after performing the tasks.

Together with the company, the goal of the study was determined. We decided to focus on some exercises, on the installation of the device and on the use of the webportal. The process of the human factor study consists of the preparation and the study design. Analysis is based on codebooks and questionnaires.

Preparation ➤ Study design ➤ Analysis
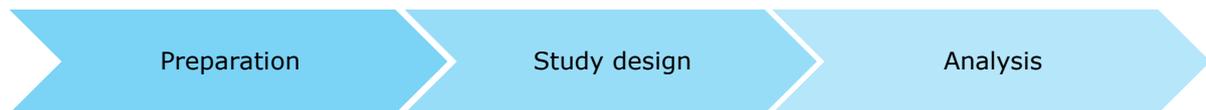
Figure 9 ACSELL | Set-up of a human factor study

Preparation

A. Sample size

A sample size of around 8 individuals is common in human factor studies and appears sufficient to detect the vast majority of usability problems. In this case we opted for including 10 healthy participants to achieve a minimum of 8 participants. Because of ethics, we decided on including healthy persons and not patients. It was preferred to have some experience with physiotherapy in the past.

The aim was to recruit a diverse population in terms of demographics (age, gender, digital literacy) and also to target vulnerable individuals for whom using the device might be more challenging.

B. Materials

- A computer
- Installation instructions
- Motiphy+ product
- Booklet and pen
- The scenario with written out instructions
- Coding sheet

C. Location and room set-up

To show the partners how the study process looks like, LiCalab recorded a video of the room set-up. It is key that the behavior of the participants while performing the exercises, is seen clearly by the observer.

In this case we collected more data via a pre -and post questionnaire. The completion of these questionnaires can be done in a separate room.

Study design

A dry run of the study process was video recorded to demonstrate to the partners how the study looked like. This example shows every step of the study design, starting with welcoming the participant up to and including thanks to the participants.

A. Informed consent and demographics (pre-questionnaire)

LiCalab made a booklet where the Informed Consent, the demographics and post questions were integrated. Each participant was provided with a printed 13 pages booklet.

We opted for a short and clear Informed Consent where the goal and the procedure briefly was explained.

B. Study

The study itself consisted of 4 components:

- Setting up the product and program
- Performing exercises
- Consulting the online platform
- Completion of the post questionnaire in the booklet

LiCalab made a fully written out powerpoint to guide each step of the study. The study design had strict instructions for the experimenter, e.g. 'You observe and score the behavior of the individual based on the codebook. You can code this live or based on the video recordings.'

The study design also stated the instructions the experimenter has to give to the participants, e.g. '"*On your right, you can find a box containing the product. On the computer in front of you, you can find instructions on how to set up the product and the program. You can interact with the computer and product as described in Step 1 of the instructions. Please report aloud exactly what you are thinking and doing when interacting with the computer and product. If you do not have any further questions at this point, you can proceed with the task. You can tell me when you have completed step 1 of the instructions.*"

While interacting with the product, the participant was encouraged to thinking aloud. The experimenter could answer practical questions concerning the tasks. However, questions on how to interact with the program, could only be answered by saying they could interact in a way they considered appropriate given the instructions. After performing the tasks, the participants were asked to complete the post questionnaire. The experimenter emphasized the openness and honesty of the feedback.

The whole study design was completed in 40 to 50 minutes.

Analysis

The analysis is based on the codebooks with the observations and the thinking aloud data. The analysis is further completed by the results of the post-questionnaire. The first analysis was provided by CEI and EKUT. LiCalab made a final analysis based on the data gathered in a concluding report.

Triangulation, or combining several methods or sources of information, improves trustworthiness of findings.

An approach combining thinking aloud data with observation checklists or survey and interview data is preferred.

Points of attention

- A dry run can uncover some practical or technical issues and will give the moderator the confidence to execute the study.
- Observations are best supported by video recordings
- By using 2 facilitators, the process can be accelerated. One facilitator welcomes the participant and goes through the informed consent and pre-questionnaire. The second facilitator goes through the tasks in another room. The participant ends up with the first facilitator for the post-questionnaire.

Challenges

- How to reach out to the ecosystem and recruit the right profiles
- IT-issues (administrator rights) with installing the program
- Privacy issues: ethical concerns on recordings.

CONCLUSION ON THE EXPERIENCE OF THE PILOT ACTION

Co-creation sessions

Recruitment proved to be a major challenge for the partners. For the Italian and German partners it was a 'cold call' to action. Neither the University of Tübingen nor CEI already have a living lab in place. It took time to explain and to discuss the goal and set-up of the activity with health authorities, network organizations; end-user organizations, colleagues… Especially the recruitment of health care professionals was difficult and time consuming.

Moreover, the pandemic was still an obstacle. Therefore the co-creations were scheduled in March and April 2022, even though they were initially scheduled in the period of November-December 2021.

While running the session, Italian and German partners were surprised about some strong reactions. It was a demanding discussion with a lot of input, both positive and negative. Care technology seemed to be a sensitive topic. Participants were happy to contribute and give their feedback.

Human Factor Study

A thorough preparation is neccesary. Both partners in Italy and Germany had to deal with IT-issues and administrator rights to install the software. The organisation's computer network did not allow for the installation of foreign software. The installation and set-up of the study demanded quite some time.

While running the study with participants, the experimenters had to get used to their role as an objective, neutral researcher with little empathy. The experimenter could not support or reaffirm the participants during the study. Because it was the first time, they were a bit insecure of doing the right thing. But after running the study a few times, their role as an experimenter felt more comfortable.

Italian and German partners saw that people felt at ease while performing the tasks. It was fascinating to uncover certain patterns already.

In Italy there were no camera recordings because of the ethical aspect. But a good focus on the live observation provided all information for the codebook.

The Pilot Action was a very learning experience. Both the preparation, the contact with the company and the cooperation with the partners provided a basis for the further development of such activities.

Preparing and facilitating the co-creation sessions and Human Factor study was challenging and a jump in the unknown. Although the partners felt a little uncertain beforehand, they were very satisfied with the course and outcome of the activities.

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APPENDIX

1. Diary study

Diary template end -user

For 6 months the NOAH sensors are installed at your home. Your feedback is key for further development of the system. We would like to ask you to maintain a brief journal with your experiences with this system. Remarks, suggestions, some strange events... that come up during the test period are more than welcome. We advise you to take notes at least once a week, for not forgetting anything.

Thank you very much for your participation.

Week 1	Yes	No	Highlight your answer	If you like, you can give more explanation or suggestions to improve
I've experienced technical issues			Low battery Disconnection sensor Problems with the smartphone Problems with the internet connection Problems opening the app Problems with logging in Other	
I have used the app			My mood Managing my contacts Checking alerts and notifications Other..	
Using the app was easy				Why yes/why no?

Other remarks or events you want to notify?

....

2. Sensitizing probe/cultural probe

3. Stakeholder mapping

Stakeholder Analysis Matrix

Stakeholder Name	Contact Person Phone, Email, Website, Address	Impact How much does the project impact them? (Low, Medium, High)	Influence How much influence do they have over the project? (Low, Medium, High)	What is important to the stakeholder?	How could the stakeholder contribute to the project?	How could the stakeholder block the project?	Strategy for engaging the stakeholder
EXAMPLE Nurses & Midwives Union	Carlos Davida cdavida@nu.org 0998 765 287	High	High	Maintaining working conditions for nurses	Agree for union members to implement the new reforms	Going on strike	Monthly round-table discussions
Patient Advocacy Group	Viki Chan vchan@pag.org 888 587 101	High	Medium	Maximising quality of care for patients	Communicate with other stakeholders to express their support for reforms	Making complaints about quality of service after the reports	Information and feedback meetings every 6 months
Sunday Times Newspaper	Jane Smith jsmith@stn.com 888 587 101	Low	High	Getting a good story	Print stories that support the new reforms	Printing stories that oppose the new reforms	Quarterly press meetings

4. Brainstorming

5. Customer journey mapping

source: https://www.designkit.org/methods/journey-map

6. Empathy mapping

source: https://gamestorming.com/update-to-the-empathy-map/

7. Personas

source: https://userinnovationtoolkit.ugent.be/#/methods/persona

8. Usability test plan dashboard

source: https://www.userfocus.co.uk/articles/usability_test_plan_dashboard.html

9. Mock-up / Wireframe

10. Lego Serious Play

source: https://www.lspmethod.com

11. Template 1_Call text pilot action

See reference document 'ACSELL_call pilot action_text newsletter English.docx'

12. Template 2_Registration form innovation

See reference document 'Registration form innovation_ACSELL_20210924_FINAL.docx'

13. Template 3_Review criteria identified innovations

See reference document 'Review criteria identified innovations ACSELL pilot action.docx'

14. Template 4_Scoring table all partners

See reference document 'Scoring table ACSELL Pilot Action_all partners.xlsx'

15. Template 5_Decision form partners

See reference document 'Decision form partners_ACSELL Pilot Action_template.xlsx'

16. Template 6_Declaration de-minimis aid

See reference document 'ACSELL_declaration deminimis aid human factor study_20210923.docx'

17. Template 7_ Scenario co-creation sessions

See reference document 'Pilot Action_careprofessionals_final.docx'

See reference document 'Pilot Action_endusers_final.docx'

18. Template 8_Scenario human factor study

See reference document 'Motiphy+scenario.pptx'