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TRANSDAIRY

TRANSDAIRY LIVING LAB MODEL

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INTRODUCTION
LIVING LABS, INNOVATION, MODELS

Living Labs are open innovation environments in real-life settings, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures. In recent years, Living Labs have become a powerful instrument for effectively involving the user at all stages of the research, development and innovation process, thereby contributing to European competitiveness and growth.

The model of living lab evolved from a triple helix to a quadruple helix and more recently to a five-helix model adding the natural environment.

The concept of living lab is related and originates from issues pertaining to the economic theory and the related concept of innovation.

The concept of helix is opposed to the linear model of innovation. The helix model is a spiral that involves sundry relationships among institutional stakeholders, public, private and academic at different stages in the use of knowledge for innovation of products, processes, and services.

Both the Triple Helix (TH) and the Quadruple Helix (QH) approaches are grounded hold the tenet that innovation is the result of an interactive process involving different stakeholders, each contributing according to its role in society. Typically, the actors in the TH are Universities, Industries, and Governments. Civil society is the additional dimension part of the QH. Contribution to innovation is envisaged in terms of sharing of knowledge and transfer of know-how, with the helix's models assigning and formalizing a precise role to each stakeholder's dimension in creating economic growth through innovation.

As society becomes more and more interactive, the role of knowledge as well as the number and scope of spheres to be included in the innovation-generating process have been increasing over time.

Innovation has been investigated and studied since the beginning of the nineteenth century because it is considered to have a relevant role in economic capitalistic theories that involve growth and competition. This dates back to the Austrian economist Schumpeter, whose ideas and theories about actors leading the innovation process were uptaken and in course of time adapted and changed with the evolution of economics, society and technology.

In the original view of Schumpeter, economic development has to be seen as a process of qualitative change driven by innovation.

In 'The theory of Economic Development' (Schumpeter, 1911) Schumpeter focuses on the Industrial domain, where the main actor is the entrepreneur that drives the innovation-generating process where innovation originates from business aspirations. In 'Capitalism, Socialism and Democracy' (Schumpeter, 1942) the large enterprises become the strategic stakeholders in the economic system, and research and development laboratories, intended as creators of knowledge from the intramural research and development activities, become an essential input for innovation. The latter can be considered as one of the first explicit recognitions of the knowledge relevance, including an indirect reference to the academic world for its role of knowledge producer within its scopes of research. While inventions can be carried out everywhere (e.g. universities) because commercial objectives are not expected, innovation, having a commercial purpose, necessarily has enterprises as the protagonists. In the process related to the creation of innovation, scientific and research progress is considered as exogenous to the economic system.

In the last century, most of the economic growth theories have been based on innovation-generating processes focusing on the role of productivity, technology change and knowledge, as well as on the role of the actors contributing to them. In the Neoclassical Growth Theory, as developed by Solow and his followers, economic growth in the long-run is the result, within the industrial domain, of the combination of capital, labor and technological progress (accounted as an exogenous element). In the 1980s, the so-called New or Endogenous Growth Theory proposed by Romer and Lucas introduced the idea of a shift from a resource-based economy to a knowledge-based economy.

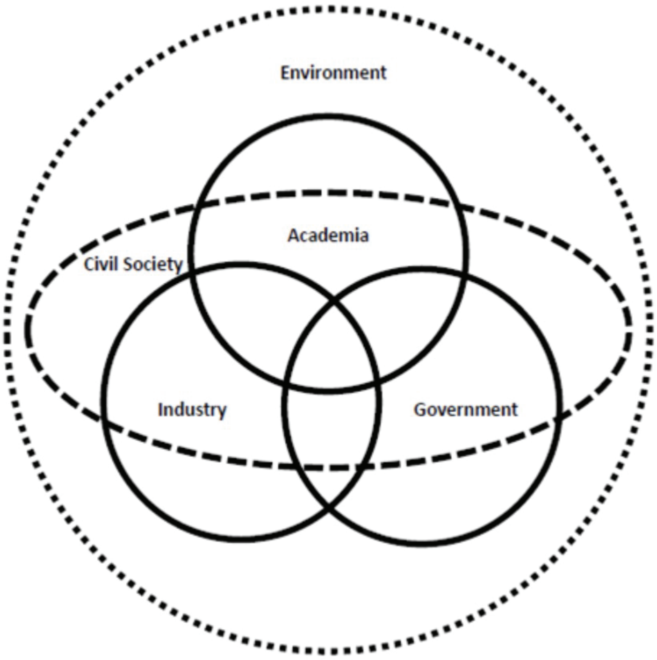
The economic processes which create and diffuse new knowledge are critical to shaping the growth of nations, communities and individual firms.

Relationships between knowledge and technological change and the role of academic research became more evident in 1994, following the publication of the book 'The new production of knowledge - The Dynamics of Science and Research in Contemporary Societies' (Gibbons et al., 1994). The authors formalized two ways of knowledge production. 'Mode 1' refers to a knowledge production system led by universities performing basic research and interested in delivering educational content explanations structured in a 'disciplinary logic' and not focused on knowledge application (Gibbons et al., 1994). 'Mode 2' refers to a knowledge production system led by universities based on the principles that science is 'applied' and technology is 'transferred': "It is our contention that there is sufficient empirical evidence to indicate that a distinct set of cognitive and social practice is beginning to emerge and these practices are different from those that govern Mode 1" (Gibbons et al., 1994).

In 1995, Etzkowitz and Leydesdorff introduced the Triple Helix model. The traditional actors in charge of creating innovation, in the industry sphere, and the traditional actors in charge of creating knowledge, in the University sphere, interact with a third sphere, the Government, in order for the creation of innovation to be directly transferred at the territorial level in terms of economic growth through a top-down approach.
More than 10 years after Gibbons' contribution on knowledge production and the definition of the Triple Helix model, Carayannis and Campbell (Carayannis, Elias G., and David FJ Campbell, eds. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters: A comparative systems approach across the United States, Europe, and Asia. Greenwood Publishing Group, 2006.) introduced a third, more complex, mode for producing knowledge (Mode 3) which had a higher number of interconnections and actors involved. 'Mode 3' entails the learning processes and dynamics of Mode 2 while integrating them with a bottom-up approach including civil society: "The Mode 3 Knowledge Production System architecture focuses on and leverages higher order learning processes and dynamics that allow for both top-down government, university, and industry policies and practices and bottom-up civil society and grassroots movements, initiatives and priorities to interact and engage with each other toward a more intelligent, effective, and efficient synthesis" (Carayannis, Elias G., and David FJ Campbell. "'Mode 3 and Quadruple Helix': toward a 21st century fractal innovation ecosystem." International journal of technology management 46.3-4 (2009): 201-234.).
In parallel, the concept of Quadruple Helix was developed by maintaining the interaction of the spheres of the Triple Helix, industry, university, government and by adding as a fourth domain involved civil society.
In the Quadruple Helix, Academia and firms provide the necessary conditions for an integrated innovation ecosystem. Governments provide the regulatory framework and the financial support for the definition and implementation of innovation strategies and policies. Civil society not only uses and applies knowledge, and demands for innovation in the form of goods and services, but also becomes an active part of the innovation system.
Information and communication technologies (ICT) work as an enabling factor of bottom-up participation of civil society.
The TH model and the QH approach added more than a theoretical framework to the economic growth theory. They were directly developed and implemented as territorial innovation approaches attempting to exploit the potential of socio-economic systems.

The quadruple and quintuple innovation helix framework describes university -industry- government- public-environment interactions within a knowledge economy and knowledge society. The quadruple and quintuple innovation helix framework was developed by Elias G. Carayannis and David F.J. Campbell, with the quadruple helix being described in 2009[3][4] and the quintuple helix in 2010.[4][5]
The quintuple helix adds the fifth helix: the natural environment and socio-ecological interactions. Nowadays it is intended to be exploited in an interdisciplinary and transdisciplinary way to sustainable development.
It is particularly well suited for those activities that heavily rely and also impact on the natural environment, such as agriculture, forestry, agro-pastoral economies, fishery etc.

Here below we present two graphic representations of the quintuple helix model of innovation:



The year 2006 is the 'official' start of European Living Labs as the movement gained real momentum through European policy measures, culminating in the birth of the pan-European network ENoLL (European Network of Living Labs). Living Labs (LLs) were closely linked to Testbeds and mainly focused on experimenting with novel technologies in a real-life context, especially in the context of ICT innovation.

However, over the years the outlook and thematic focus of LLs started to diversify and were influenced and fueled by the growth of European national and regional innovation networks, and pioneering companies.

LLs nowadays include multiple stakeholders and their roles. Such network structures possess advantages for innovation in short and long terms.

Several studies have also looked into concrete impact and outcomes of LLs. Nowadays, they are sometimes considered as platforms with shared resources, which organize and support the stakeholders into collaborative networks that rely on shared governance, participation, open standards, and diverse activities and methods to gather, create, communicate, and deliver new knowledge, validated solutions, professional development, and social impact in real-life contexts. LLs facilitate the development of people and communities for the use of innovation, i.e They contribute to environmental and social improvements as well as economic development and mainly deal with so-called 'wicked problems. Moreover, LLs are regarded as innovation approaches linked to the generation and development of innovative business models and innovation management approaches. The LLs movement has grown to a worldwide phenomenon, both in terms of research and practice. ENoLL has already accredited nearly 500 LLs worldwide and currently counts more than 125 active members. In terms of publications, the search term "living labs' ' on google scholar results in a number of articles in the order of 100 of thousands.

Quadruple and Quintuple Helices have been adopted by the European Committee for the Regions and by the European Commission, as metaphors for further strategy development such as in European Union (EU) programs for Smart Specialization, Plan S, Open Innovation 2.0, etc

McPhee et Al. studied agroecosystem LLs and analyzed country-wide LL cases in Canada and France, including in their paper eight supporting cases. The study provides characteristics of agroecosystem LLs, meaning that such characteristics create a foundation in an emergent sub-field of agroecosystem LLs. The study brings closer seemingly different urban and rural LLs. Last, the study develops new types of LLs, namely agroecosystem LLs (McPhee, C.; Bancerz, M.; Mambrini-Doudet, M.; Chrétien, F.; Huyghe, C.; Gracia-Garza, J. The Defining Characteristics of Agroecosystem Living Labs.Sustainability2021,13, 1718)

Bronson et al. wrote a review about LLs in agriculture. They focused on agriculture and sustainable LLs. They reviewed the literature identifying types of publications and the kind of studied context. The results summarize the diversity of phases of innovation activities. (Bronson, K.; Devkota, R.; Nguyen, V. Moving toward Generalizability? A Scoping Review on Measuring the Impact of Living Labs Sustainability 2021,13, 502)

The Defining Characteristics of Agroecosystem Living LabsChris McPhee1, Margaret Bancerz, Muriel Mambrini-Doudet, François Chrétien, Christian Huyghe and Javier Gracia-Garza Indeed, since the mid-2000s, a rich body of scholarly literature has been developed (e.g., [17–19]) and has been complemented by various handbooks to assist in the study and practical implementation of living labs (e.g., [20,21]).
Any prospective living lab now has much general information to draw upon in setting up a living lab and customizing its implementation to suit its objectives.

Similarly, researchers can also build upon a body of literature that seeks to understand and explore the living labs approach. For example,the literature offers insights on the way living labs function and foster innovation in terms of living labs as open innovation networks (e.g., [22,23]); the roles of users, stakeholders, and other actors (e.g., [24–26]); innovation methodologies and tools (e.g., [27–29]); business model innovation [30,31], and many other topics. However, the evaluation of the actual impact of a living lab in terms of innovation process, effective adoption, and sustainable changes is still a notable gap [32,33].

There are also studies targeting specific application contexts. For example, researchers and practitioners alike have identified the “urban living lab” (ULL) as a particular type of living lab that is distinct from more general applications [18,34], as will be discussed in this paper as an analogous effort. The persistence of the ULL concept in the literature suggests it does have some scholarly and practical value in identifying and understanding it as a distinct type, and making the link between the innovations expected from a living and the way it is run. If we look at agriculture as an application context, the living lab approach is not new. European projects aiming to use living labs as instruments for rural development were launched in the early 2000s [35]. However, they focused on economic and social development in communities rather than in agriculture or food production.

More recently,the term living lab has been used to identify innovation initiatives in the agriculture and agri-food sector, such as the “Agro Living Lab” for agri-machinery in Finland, the “Homokháti Living Lab” for agriculture and tourism in Hungary, and the “PA4ALL” for precision agriculture in Serbia, among others. However, using the living lab approach at an agroecosystem scale is new and presents unique challenges that make it both challenging to implement and interesting to study.

Living labs means different things to different stakeholders [36], but it may be inferred that in agroecosystems, living labs encourage the involvement of multiple stakeholders (farmers, food industry companies, retailers, researchers, students, non-governmental organizations, Indigenous communities, governmental institutions, financial institutions,small and medium-sized enterprises, consumers, advisory services and other members of the national Agriculture Knowledge and Information System) [37], and with end users playing a central role. Together, they co-create, explore, and evaluate innovations within the users’ real-life context, meaning this is an extension of the “usual” agriculture system innovation processes and promotes “on-field” experimentation.

For agroecosystem living labs, the three general components outlined in the international working group’s definition form a high-level framework that helps differentiate the living labs approach from other innovation processes in agriculture.

But the definition’s value in guiding the implementation of the agroecosystem living lab concept may be limited because it is not yet anchored in the literature and is not sufficiently differentiated from the general principles common to all living labs.
Because the concept has been implemented only recently, there is a lack of documented experiences or studies for those seeking practical implementation insights. Identifying and describing what makes agroecosystem living labs unique, including their distinctive challenges and opportunities, would not only provide a much-needed next step for future researchers, it would have immediate practical value for living lab managers and those seeking to start a living lab for improving the sustainability and resilience of an agriculture and agri-food system.

Typically, in LLs it is possible to distinguish three interlinked layers: the LL organization, the LL projects, and the individual user and stakeholder activities.
The top layer of the model can be associated with Open Innovation, whereas the bottom layer is in line with User Innovation.

The TRANSDAIRY project

The TRANSDAIRY project created eight living labs. Four LLs were dedicated to ICT technologies for the Dairy Value Chain (DVC) and four were dedicated to bio and nano technologies for the DVC.

The project, through the LLs, creates an effective encounter of demand and possible solutions offered by research results, becoming the midpoint between the 5 instances involved in the Quintuple Helix approach.

Table 1 list of the TRANSDAIRY project Living Labs (LLs)

Type of Technology	Name of Managing Entity	Entity Type
ICT	***Università della Campania L. Vanvitelli***	***University***
ICT	***ICSS***	***University***
ICT	***IRI***	***Research***
ICT	***APII*** *Agency for the Promotion of Industry and Innovation*	***Governmental agency***
Bio and nano technologies	***ESIM***	***University***
Bio and nano technologies	***AUA*** *Agriculture University of Athens*	***University***
Bio and nano technologies	***Berytech***	***Innovation agency***
Bio and nano technologies	***CNR***	***Governmental Research***

TRANSDAIRY involves the following services and activities:

- Focus groups
- Open days
- Training classes for specialized intermediaries
- Training classes for entrepreneurship
- Vouchers for Spin-offs
- Vouchers for patents
- Technical support for co-development
- Cross border databases on KET offer and demand
- Front desk services
- Brokerage events
- Open collaborative platform
- Links of the partners to regional/national political & administrative levels
- Questionnaires and surveys

The main lessons from the activities implementation of the activities showed that the following:

- The effort to involve stakeholders is challenging.
- Direct contact at events or through telephone calls is the most effective way to involve stakeholders
- Leveraging pre-extant events allows wider reach of stakeholders that are already oriented to gain information and to innovation

-The number of technologies potentially transferable to the Dairy Chain in the two areas of ICT and Bio-nanotechnologies is relevant but most of them have a low Technology Readiness Level and are not directly applicable

-Living Labs long term sustainability should receive support from external funding either from public or private donors

The TRANSDAIRY project identified the following possible end points of the activities.

These are key aspects that may set the ground for Living Labs continuation of activities, as well as for new and future Living Labs, areas of technology scouting, or implementation focused projects.

- **Improves water and energy efficiency**, diminishes carbon footprint, counteracts water scarcity By-products re-use and valorization towards a zero-waste circular economy
- **Improves animal welfare and health**, reduces antibiotic use and bacterial resistance
- **Improves milk safety**, reduces contamination and pathogens diffusion to the environment and humans
- **Improves collection and logistics**, diminishes fossil fuel emissions.
- **Alternative energy production** (such a biogas) integrated to milk processing plants, using also by products
- **Preserves marginal rural areas weak environment and landscape**: Enhanced DVC productivity supports the small farmers, avoid over exploitation.
- **Improves local high productivity**, reduces imports (long haul derived carbon footprint),
- **Eases access to market**: Short and efficient distribution chain
- **Better cold chain less discard of milk**
- **Sustainable solutions for small farms** with life work balance and environmentally sound
- **Ethical and gender aware design of ICT/bio nanotech solutions**,
- **Feedback** from users/consumers/value chain stakeholders/social and civil society stakeholders involving the local and regional political administrative level, the coaching offer, etc.

Living Lab model handbook

This handbook is based on the partners' experience in the TRANSDAIRY project.

The first section of the Model is structured in a series of activities that are ordered according to a timeline for the design, development, and implementation of the living lab.
Once up and running a living lab will possibly have multiple different activities running in parallel with different branching projects and subprojects.

The TRANSDAIRY model

TRANSDAIRY focused on activities to create a critical mass of experts and actors to foster the development of innovative solutions for the DVC.

The end point of the activities is the creation of spin-offs and patents, possibly with a partnership across borders of the Mediterranean countries.
Under this regard the TRANSDAIRY approach is different from the typical Living Lab in which products or applications of technologies are developed from the initial inception up to working prototypes with high TRL. This typical Living Lab activity is not much different from any other technology development project.

Essentially in the Living Lab it is based on a wider collaboration with user's and stakeholders, but it is more or less what is done in private companies, or in European Funded projects for technology development such as in H2020 or in Horizon Europe, where the involvement of end users, and demonstrations are more or less mandatory, whereas also sometimes the involvement of artist or citizens is requested in the calls.
In TRANSDAIRY the development of contrivances is not directly supported, through all the typical phases of product development.

There are technologies scouting activities and technology demand surveys across the different stakeholders involved in the Dairy value chain.
The role of the TRANSDAIRY eight Living Labs is to make the two sides, demand and offer, meet and collaborate. In other words, to foster fruitful collaborative encounters.
The result of the encounters shall be substantiated in the creation of spin-offs to make the technology amenable to the Dairy Value Chain stakeholders needs and create the innovative products.

Spin-off definition
A Research Institution or University spin-off is a company founded by researchers to enhance the results of their own research activity and scientific knowledge, in which the University may be a partner.
Researchers, as partners, usually work in the company and share the profits. From the legal viewpoint, a spin-off is no different from an ordinary business enterprise.
The partnership of a spin off- can include sundry types of actors.

Therefore, the TRANSDAIRY Living Lab Model includes the following preparatory and critical mass creation activities:

- Creation of cross border databases of demand and offer of Key Enabling Technologies and solutions for the Dairy Value Chain (DVC)
- Interviews, Questionnaires and surveys
- Front desk services
- Open collaborative platform
- Dissemination and communication plan implementation
- Networking of the partners to regional/national political & administrative levels
- Focus groups
- Open days
- Vouchers for participation in training courses
- Training classes on technology transfer for specialized intermediaries
- Training classes on entrepreneurship for women and youngers

The following activities are those that can be implemented once created the critical mass and raised interest in the actors to be involved:

- Brokerage events
- Technical support for co-development based on technology transfer from Research to the Dairy Value Chain.
- Vouchers for Spin-offs
- Vouchers for patents

Some activities are recurrent such as the training classes, so far, the model is not linear, with a waterfall of activities in a chain, but involves activities performed in parallel.
For example, dissemination and communication activities are to be performed all along the LL lifespan.

The Initial Strategic Analysis

Creating a common understanding of your Living Labs is the basic step.
You must define the scope of the Living Labs, and identify key open questions, key issues to be improved to the technology transfer, practical problems to be solved within the Living Labs.
What are the general strategic objectives of the LL?
You also want to identify the end users and stakeholder considering their role in the value chain and in the socio-economical context.
Also, you must identify the creation of value of your LL.
What is the value that you are producing for the end users?
What is the value that you are producing for the other categories of stakeholders and actors?
What technologies do you want to be the focus of your Living Lab?
Is there already any virtuous example of a successful product/contrivance/service process based on such technologies for your sector of interest (e.g. in TRANSDAIRY the Dairy Value Chain)?
Are there local providers (research institutions, start-ups. spin-offs, lab of enterprises) of such technologies to be transferred to your value chain of interest?

Example of summary table for Initial strategic analysis

Key issue	Users	Stakeholders	Value Creation

In our model, before setting up a Living Lab is it necessary to:

- Analyze the current local situation under the axis of the multiple helix model and write down a detailed planning and organization of the activities to identify open questions and identify stakeholders

You should give special attention to pre-extant informal networks of collaboration, of commercial exchanges, of information exchanges (in Italy typically for farmers in villages and small towns the examples are the cattle market, the agriculture machinery fair, the bar in the main square of the village on Saturday morning where they discuss the hay price, the Km zero market of the village etc.)

Also pay attention to associations and unions of stakeholders such as farmers, breeders, young entrepreneurs association.

Identify the users and stakeholders to be involved in the living lab

In simple words, you may want to have the personnel of the LL acting as organizer and facilitator. the end users and stakeholders as co-creators and provider of needs and requirements, as well as reviewer of the concepts, prototypes and contrivances, products, processes.

You may also want to involve users and stakeholder that are located upstream or downstream in the value chain so that your contrivances will fit in the value chain and local socio-economic context.
Also, you may want to include local administrative and political personnel, as well as civil societies organizations, especially when dealing with environment and sustainability, or socio-economic and ethical issues.

Define the LL approach

Once defined the objectives, you may want to define your LL approach.

Living Labs may be classified in very different ways and sundry taxonomies exist in relation to their approach and typology.
It is important to clearly define the kind of LL you want to set-up because different types involve different organizational and governance issues, and different networking and participatory activities.

Defining Living Labs

The “living lab” concept has proven attractive to practitioners and researchers alike. Over the past two decades, the living labs approach has been applied in a variety of contexts and sectors, originally focused on technological innovation but later expanded to include broader social challenges in areas such as eHealth, smart cities, public sector innovation, university campuses, and rural development. The term is in some cases considered an approach or methodology for collaborative innovation, an arena or environment in which the innovation activities take place, or a broader ecosystem or open innovation network, among other interpretations.

Various definitions have been proposed to give clarity to the concept, although the resulting definitions each emphasize certain aspects over others (see Steen and van Bueren for examples), and no single definition has become particularly dominant or gained widespread acceptance. However, the present paper uses the commonly cited definition from the European Network of Living Labs (ENoLL), which identifies living labs “as user-centered, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings”. ENoLL also lists five elements that must be present in a living lab: (1) active user involvement, (2) real-life setting, (3) multi-stakeholder participation, (4) multi-method approach, and (5) co-creation. Indeed, others have also offered sets of elements or characteristics to help clarify exactly what a living lab is (and is not) or to differentiate between particular “types” of living labs.

Thus, rather than trying to resolve the challenge of finding a unifying definition, researchers have sought to identify key principles or characteristics that are common to all living labs and therefore represent a general model of a living lab that may be elaborated upon or interpreted to suit the context of implementation, if required. The operationalization of the principles “in the field” can further inform our interpretations of these characteristics or principles and have led to the recognition of various “types” of living labs.

Living Lab Typologies

Partly driven by the need to build consensus, delineate concepts, and distinguish between different applications that carry a common label, researchers have developed various typologies of living labs. Typologies are artificial constructs that can help researchers and practitioners classify living labs.

Generally, a typology proponent selects a particular dimension to categorize living labs. The choice of dimension depends on the proponent's perspective and goals: it may reflect some practical reality or salient feature, it may seek to reveal an underlying phenomenon for academic study, or it may be used to identify a unique manifestation or differentiate it from a general model, which can be particularly useful if the goal is to understand a newly emerging form of living lab. Thus, typologies can have practical benefits in teasing out what might be unique about particular application contexts and why certain approaches may or may not work within them.

Examples of dimensions used to develop living lab typologies includes:

- **Sector:** The most common way to categorize different types of living labs is by sector, thematic domain, or area of application. For example, ENoLL uses sectors to categorize its membership: Health & Wellbeing, Smart Cities & Regions, Culture & Creativity, Energy, Mobility, Social Inclusion, Social Innovation, Government, Education, and Other.
(Within this typology, certain living labs could be described as "agriculture living labs," although we will show why this label fails to capture key challenges associated with a particular category of living lab in this sector: agroecosystem living labs.)

- **Purpose or function:** Efforts to distinguish living labs by their purpose or function have been part of an overall effort to clarify the living lab concept and separate out distinct clusters of "living labs" that all use this common label to represent somewhat different applications (e.g., European vs. American approaches or ICT innovations vs. engineering testbeds).

- **Driving actor:** Actors can play varying roles within a living lab, and various coordination, management, and governance structures are possible within living labs. Leminen, Westerlund, and Nyström [22] propose a typology that differentiates living labs based on who drives the activities, resulting in four types of living labs: utilizer-driven, enabler-driven, provider-driven, and user-driven.

- **Processes and approaches:** Researchers have also based typologies on their coordination approach and participation approach. This approach has been combined with a platform of dimension to categorize living labs as different types of collaborative innovation networks.

Leminen and Westerlund [27] have further proposed a related typology based on the innovation processes and tools used in living labs.

Typologies are not mutually exclusive—a given living lab could be recognized in multiple typologies at the same time. For example, a living lab could be a "mobility living lab" according to ENoLL's sectoral typology while at the same time being a "utilizer-driven living lab" according to Leminen et al.'s typology [22].

However, in some cases, labels have been applied to certain types of living labs that do not fit into any existing or explicit typology but rather serve to distinguish a particular "type" of living lab from the general model of living lab. Through our experience and knowledge of the living labs literature, we recognize two such "types without a typology" that are particularly relevant to better understand agroecosystem living labs: "ULLs" and "rural living labs."

Compared to rural living labs, the literature on ULLs is more abundant. Moreover, our first author's years of experience helping ULL researchers articulate the unique characteristics of this new type of living lab in contrast to the general model of living labs drew our attention to the similarities with the objectives of this study.

Indeed, the efforts of ULL researchers to identify the defining characteristics of ULLs provide us with a body of literature from which to develop a conceptual framework to guide our own parallel efforts.

In the TRANSDAIRY approach and model the higher the TRL the better it is.
A higher TRL of the technologies increase the possibility of short-term practical adaptation to the value chain stakeholders' needs. This entails an increased viability for the newly created spin-offs with a lower burden of initial investments for the industrialization of the contrivance, in other words to upbring it to TRL9

Phases in a recursive approach to the development of a technological contrivance (socio technical artifact):

- Users' needs analysis
- Users' Requirements definition
- Concept creation
- Technical requirements definition
- Mock-up of the solutions
- Review and test mock-up in collaboration with your base of users and stakeholders
- Re-analyze and update requirements
- Development of components of the contrivance/device/service/process
- Review of the components prototypes in collaboration with users and stakeholders
- Requirements update
- Components prototypes updates
- Final review of components in collaboration with the end users and stakeholders
- First integrated prototype review and lab tests with end users and stakeholders
- Update of requirements
- Integrated prototype version 2 review and lab test
- Upgrade of prototype to version for test in real environment
- Review and test of prototype version 3 in the real environment in collaboration with users
- "Industrialization" brings your contrivance from the level of prototype to the level of product: TRL Technology Readiness Level 9

Define the Governance of the LL

You should perform this activity involving local actors, considering the relevance of civil society, small farmers, cooperatives, NGO, association that locally will act as providers of requirements, ideas, know-how, and will be co-designers, mid-term testers, as well as demonstrators and end users.

The end points are a written agreement and definition of the governance approach and decision making and the creation of a governance committee.

Since innovation happens in a social context and brings about social changes, governance is very important in order to foster the active involvement of the actors for the coordination of relations and organization of cooperation of the collective collaborative process among social actors.

The Living Lab constellation should provide decision-making opportunities to all stakeholders. Involving from the beginning a representative from each stakeholder group will help to form a governance model and an appropriate legal form when the Living Lab is mature enough (i.e. integrated in an association, a charity, cooperative, etc.). The model should mirror a circle of mediators where there are no dominating voices. All stakeholders are in some way providers.

The governance committee shall take care among others of:

- Performance of the LL
- Sustainability of the LL
- Collaboration and communication with stakeholders
- Visibility and dissemination of LL activities
- Multi-business collaboration and issue of openness
- Flexibility and fast changing requirements
- Financial issues
- Technical and infrastructural challenges
- Integrating social and technical aspects of LL activities
- Keeping user motivated, in the LL projects
- Balance between research and development activities
- Mutual learning
- Visibility and dissemination of LL activities
- Multi-business collaboration and issue of openness

Identify ICT tools to support the LL activities and services

ICT tools such as an open collaborative platform that works as a virtual location for encounters and development of ideas, is needed.
There are also plenty of ready-made ICT products for “customer relationships” that can be also exploited for the scopes of a Living Lab.
A preliminary analysis of what is needed in terms of ICT tools will be based on the model of Living Lab and the kind of activities you are going to perform.
In general, you will need an “open” set of tools to be used by your customers i.e. the stakeholders and trainees, and a set of private tools for the core Living Lab back-office activities and their management.

Create a database of local stakeholders pertaining to the five helix domains

This activity is to be performed during the first phase of creation of the Living Lab.
This is the basis to perform the other activities and to involve them in the LL developments.
A survey about their needs will also allow not only to then scout for adequate technology to satisfy their needs with innovative contrivance but also to identify those that can be the so-called early adopters, and also to identify those that are open to collaboration and really aim at improvements through new solutions.
On this axis you then can create focus groups, and other collaborative co creation and co-development activities.

Define KPIs for the LL activities in collaboration with the five helix stakeholders.

KPI shall be defined for the process, for the user's satisfaction, for the projects.
KPI shall be defined for the sundry dimensions and impacts of the LL activities such co-creation of innovative contrivances, processes, and services, environmental impact, economic impact, social impact.
Identify a project Management system and Model for the LL projects

Write an initial outreach and media plan inclusive of networking activities

The following table is a useful tool to provide basic ground to structure your plan in a synthetic and concise way.

A detailed plan shall include:

- a detailed analysis of the involved stakeholders
- the creation of database of the stakeholders, inclusive of contacts details, and planned means of contact. This database will be updated with the results of the contacts and other specific details, and future actions related to those stakeholders
- a detailed calendar of activities to reach out the stakeholders
- the reporting format standardized for update of the database
- this database will be harmonized and in some cases, it will become part of the databases mentioned in the next chapter

Stakeholder	Description	Dissemination objectives	Engagement tools
Distributors and partners	Companies with relevant sales force in the target market	Introduction of the novel HIS system in the market	Workshops F2F visits Conferences, events, Trade fairs, Website, Social network, Videos
International food industry associations	Key food industry associations in the target markets (e.g. International Agri Food Network)	Communication of the novel system as an innovative alternative for quality assurance in food industry	Specific meetings Conferences, Events, Trade fairs Website, Social network, Videos

Analyze demand and offer of innovative technologies

Here you will need to create, according to the TRANSDAIRY approach, a database of demand of technology, and a database of the offer of technology by the research community.
To create a database of demand for innovative technology you have to create a list of stakeholders and perform a survey with questionnaires and interviews.

This activity is the equivalent of market survey, in which you identify the needs, expectations and desires of the stakeholders and end users of your value chain of interest.

To analyze the offer gain, you need to create a database of the offer through an activity of technology scouting. This can be done with different approaches involving internet searches, chamber of commerce databases, association of relevant stakeholders, for example in TRANSDAIRY farmers' associations and unions, milk derivatives industrial associations, internet searches, and again questionnaires and interviews.

The technologies shall be characterized and classified cross referencing them to the sundry aspects of suitability for the application and the value chain of your interest, inclusive of social impacts, environmental impact. ethical and gender aspects.

Detailed planning and organization of the Living Lab

This activity is performed to address open questions and identify stakeholders and users roles and modalities of participation.
A plan of the deployment of the Living Lab activities in course of time shall be defined, inclusive of checkpoints and progress assessment to be detailed and quantified using the Key Performance Indexes (KPIs).

Prepare a Sustainability and economic viability plan for the LL (“Business model”)

This activity shall include:
the initial analyzes the State of the art of services provided by other Innovation related structures in your region.

- The performance a market assessment of paid Innovation related services
- The identification of possible revenues streams such as paid services
- The Identification of sources of funding either private or public
- The possibility to invest and participate as associate in spin-off and start-ups
- The identification of investors and business angels.
- Identify foreseen Exploitable outputs of your LL
- Identify commercial oriented outputs
- Identify non-commercial oriented outputs
- Identify collaboration for development with other developers or extents businesses or stakeholders
- Analyze the open collaborative platform as a possible source of revenues

Here you need to devise a viable business model that offers value to all different types of new and/or involved stakeholders is key to the sustainability of a Living Lab.
Critical elements to be considered are, for example, funding sources, value proposition, lean approach, impact, purpose, and key metrics. In addition, all the phases of a lifecycle approach should be considered: from ideation to design, experimentation and validation.
Important aspects in this part of the evaluation are, among others, proof of integration of the Living Lab operations into innovation ecosystems, SWOT-analysis of a Living Lab, a roadmap for the future, and a value chain approach throughout the operations of a Living Lab.
Your Business model shall include a Market assessment and preliminary exploitation vision.

Prepare a Living Lab Canvas

As part of your business model, you need to prepare a Living Lab Canvas.
The business model canvas is a table that represents the key aspects of a business model.
This canvas is also fit to model in a simplified way the essential elements for the development of your Living Lab.
The basic elements of a Business Model Canvas are the following, but you have to consider that different authors include different elements, so you may want to adapt the canvas elements to your specific needs and concept:

- Customer segments: Which customers do I serve and which “activities” are carried out by my customers?
- Customer relationship: which are the phases and activities to reach out to your potential and actual clients? What kind of relationship do you have with your customers? How can you acquire customers?
- Value proposition: What is the value that you offer to the customer? What does the customer achieve by using my product or service?
- Channels: How can customers be reached?
- Revenue streams: Which possible income sources do you envision? Public and/or Private funding? Paid services? What are funding institutions, investors, customers willing to pay for and how?
- Key resources: What resources (personnel, knowledge, time, money, etc.) do you need to create value?
- Key activities: What activities should be done to create value?
- Key partners: Which partnerships are necessary?
- Cost structure: What are the resulting costs? Are they fixed or variable?

Furthermore, metrics for each key aspect of the canvas shall be defined and used to monitor your activities and developments.

KEY PARTNERS

beneficiaries

Other subjects: technology providers, actors of the value chain, representative of associations and of civil society organizations

Experts specialized in commercialization

Local administration, local political level.

KEY ACTIVITIES

Analysis of customer needs and development of feasibility studies of technology transfer and adaptation

scale up of the solution

Dissemination

KEY RESOURCES

Extant innovative tech assets by research institutions, Intellectual properties, know how, human resources

UNIQUE VALUE PROPOSITION

Improvements in the quality of the DVC products.

Improvements of productivity of farmers and other actors of the value chain in a sustainable approach

Safeguard of the environment

New products and services based on users needs increase competitiveness

Positive social impact on target groups, women and youngsters that are also those with more drive for changes and application of innovation.

Economic benefits

Social and environmental impact

Prototypes, products or services

Intellectual property

CUSTOMER RELATIONSHIP

Engagement strategy

Initial contacts

Feasibility study and development of a demo

Continuous support to users and stakeholders

CHANNELS

Website

Open Collaborative Platform

Workshops

Focus groups

Vouchers for training

Vouchers to create new innovative enterprises (spin-off and start-ups)

Presence in events

Visit to users' and stakeholders' premises

Visit to tech providers facilities

Show cases and Demos at the LL

CUSTOMER SEGMENTS

Primary segments: Women and youngers, innovation oriented as co-creators of new solutions

DVC actors as users and stakeholders

Secondary segments: the agricultural and industrial sectors of the DVC

COST STRUCTURE

Engagement and media

Dissemination and communication materials

Qualified personnel

Training courses

Vouchers

Brokerage and other events

Co-creation (focus groups, workshops, interviews)

Demo activities

REVENUE STREAMS

Public funding

Private funding from medium and big players of the value chain

Training services

Co-financing of start-ups and spin-offs, of products/services industrialization and participation in the economic benefits

Technology scouting for investors

Analyze and evaluate the external context and identify risks for your LL development and sustainability

Since business models function in a specific context, at least the following areas need to be mapped using the so-called Environment Map:

- Market forces: growing or shrinking customer segments, pains and gains
- Key trends, such as technology innovations, regulatory constraints, social trends
- Industry forces, namely key actors, such as competitors, value chain actors, technology providers
- Macroeconomic forces, such as global market conditions
- Political context
- Environmental issues

The table presented here below is a tool to formalize your analysis.

POLITICAL Factors	DESCRIPTION	Risks
Technology policy adopted by the Government, funding etc.		
Regulatory barriers in the target domain		
TECHNOLOGICAL Factors	**DESCRIPTION**	
AI and Cybersecurity		
Digitization of the value chain		
Lack of standards and reference architectures		
Data		
ECONOMIC Factors	**DESCRIPTION**	
Organizational and process changes.		
Costs innovation related		
Financial investment requirements.		
ENVIRONMENTAL factors	**DESCRIPTION**	
Waste, by-products, pollutants		
Impact on landscape		
Impact on agricultural land, water, soil		
Global warming and CO2		
SOCIO-CULTURAL Factors	**DESCRIPTION**	
Social Sustainability		
Employment requirements Need for enhanced skills		
Acceptance		
Societal Issues		

LEGAL, Regulatory, Standards	DESCRIPTION	
IPR Intellectual Property Rights		
Legal Issues		
Ethical Issues		
Gender issue		
Environmental factors		

Once analyzed the sundry factors and identified the possible risk you may want to structure the analysis of risks in a table.

In some cases, such as those of risks with a high likelihood of manifestation, you may want to adopt preventive and preemptive measures immediately.

Table of the Critical risks for implementation and longer-term sustainability

Description of risk	Category	Proposed risk-mitigation measures
Underperformance in the use of ICT tools Likelihood: Medium Severity: Medium	Technical	Repeat training process of the involved personnel
Insufficient adherence to the Communication plan Likelihood: Medium Severity: Low	Management	Reanalyze communication plan in collaboration with the responsible personnel, and identify weak points of the implementation, adopt better micromanagement policy.
Diminution of the market i.e. interest in new solution due to global players market dominance and monopolization Likelihood: Medium Severity: High	Externalities: Economics	Leverage the unique value of the spin-off solution and their better adaptation to the needs of the co creating stakeholders and users

Characterization of the demand for Innovation and technology transfer services

Essentially you will map the demand for innovation in your geographical area. Typically, your geographical area of interest may be at regional or province level.
This is a necessary phase because your general scope in transferring technologies is to create encounters of demand with offer.

Characterization of the offer of Innovation and technology transfer services

This is the necessary complement of the previous phase.
It will also allow you to focus your activities in geographical areas where the demand is high and the offer low.
This phase shall include the Analysis of competitors i.e. other Technology transfer structures, hubs and services.
The Competitors can be a positive factor for possible synergies and scale app approaches.
Additionally, you may want to perform an Analysis of results from recent local technology transfer and innovation initiatives, programs, projects.
The latter analysis will also help you in identifying possible sources of funding for your LL.

Structuring of activities as “projects”

Once you have set-up the living lab you may start “projects” of technology adaptation and transfer to answer to the needs and key issues identified for the sector on which your LL focusses.
Each project will undergo some of the phases that you went through during the creation and set up of your living lab.

The activities such as preparing a demo of a technology or of a prototype, the development of a prototype, the adaptation of the prototype to the specific technical domain of interest of your LL, etc, have to be structured and managed.
In TRANSDAIRY as previously said the model is to make offer and demand meet and promote further developments through vouchers for spin-off and for patents.
Since you are working with technologies and contrivances, one possible approach is to structure these kinds of activities as a project.
Here you will have to define a lean management structure, refer to standards for recursive, user based, co-design and co-creation projects.
Also, you have to define the documents and data repository structure and analyze the IPR issues.
A written IPR agreement is mandatory, also in relation to dissemination and communication.
Starting a Living Lab product/technology application development project (a demo, a prototype development, an extant contrivance/process adaptation etc) you may want to:

- Identify foreseen Exploitable outputs of your project
- Identify commercial oriented outputs
- Identify non-commercial oriented outputs
- Define an Exploitation strategy and business model

Living Lab Exploitation outputs offering

The following shall be identified:
- Non-Commercial oriented offering
- Commercial oriented offering

The exploitable outcomes may be formalized with the help of the following scheme.

Exploitable Outcome	...
Stakeholders involved	
In what area do you expect to make an impact?	
What needs might be solved/met thanks to the results of your project outcome?	
What outputs will be created?	
Where will the outcomes be made available during and after the project?	
Who are the potential beneficiaries and users of your outcomes?	
How will you contact them?	
What is the envisioned timeline for the outcome's exploitation path?	
What are the interested stakeholders' categories?	
What is the interested stakeholder's individual exploitation paths and plans?	
Are there possible joint exploitation approaches (University-other stakeholders, Spin-off- other stakeholders, Spin-off-Living Lab)?	

SWOT analysis

A SWOT analysis shall be performed for the exploitable outcomes, technologies, products, services. The SWOT analysis is a tool used to evaluate the competitive position of a company, and to develop the strategic planning in line with the characteristics of the environment surrounding the company.

Usually, the SWOT analysis consists in the assessment of four components that are visually represented in a 2x2 table.

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. The first two components (that are on the first row of the table) focus on the analysis of the characteristics of the company and its offer, while the second two components (on the second row of the table) focus on the analysis of the context.

The SWOT analysis then results in a consistency check between what the market requires and what the company offers.

The following paragraphs analyze the four components separately, starting from those relating to the context, then focusing on the characteristics of the contrivance offered and, finally, carrying out a consistency check.

The table here below provides an example of the possible items to be identified in the four SWOT categories for a robotic contrivance for milk derivatives production.

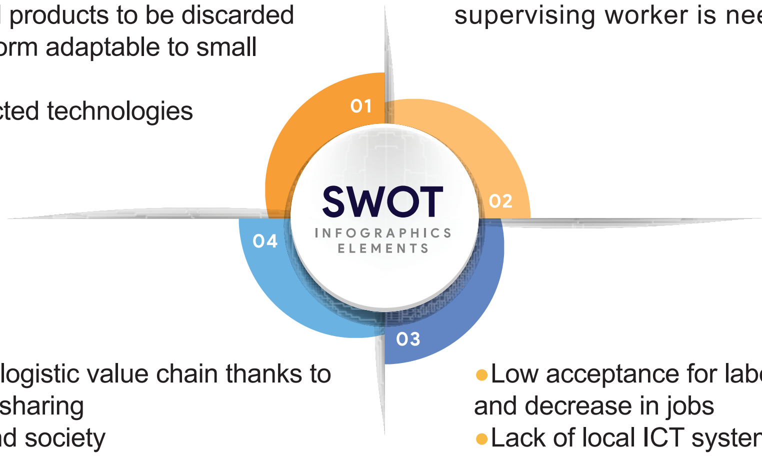
In the case of the LL creation and set-up the SWOT analysis shall refer to the general aspects of the LL. It will also be done in specific cases and projects of technology transfer of the LL.

STRENGTHS

- Collaborative Robotics System
- Improved working conditions (ergonomics, repetitive tasks, etc)
- Improved hygiene during milk derivative production
- Diminution of errors and products to be discarded
- Flexible Hardware Platform adaptable to small producers
- Use of the latest connected technologies

WEAKNESSES

- The initial investment is expensive
It cannot substitute at 100% the workers role
- Specific training for skills of the supervising worker is needed



OPPORTUNITIES

- Better integration in the logistic value chain thanks to connectedness and data sharing
- Evolution of lifestyles and society
- Time and cost saving trends for industries
- Greater awareness and attention to the safety and quality of the workplace
- Growing demand for new technologies to modernize production processes

THREATS

- Low acceptance for labor replacement and decrease in jobs
- Lack of local ICT systems well developed
- Lack of connectedness and data sharing the value chain (logistic and production value chains)
- Lack of standards and reference architectures
- Ethical issues

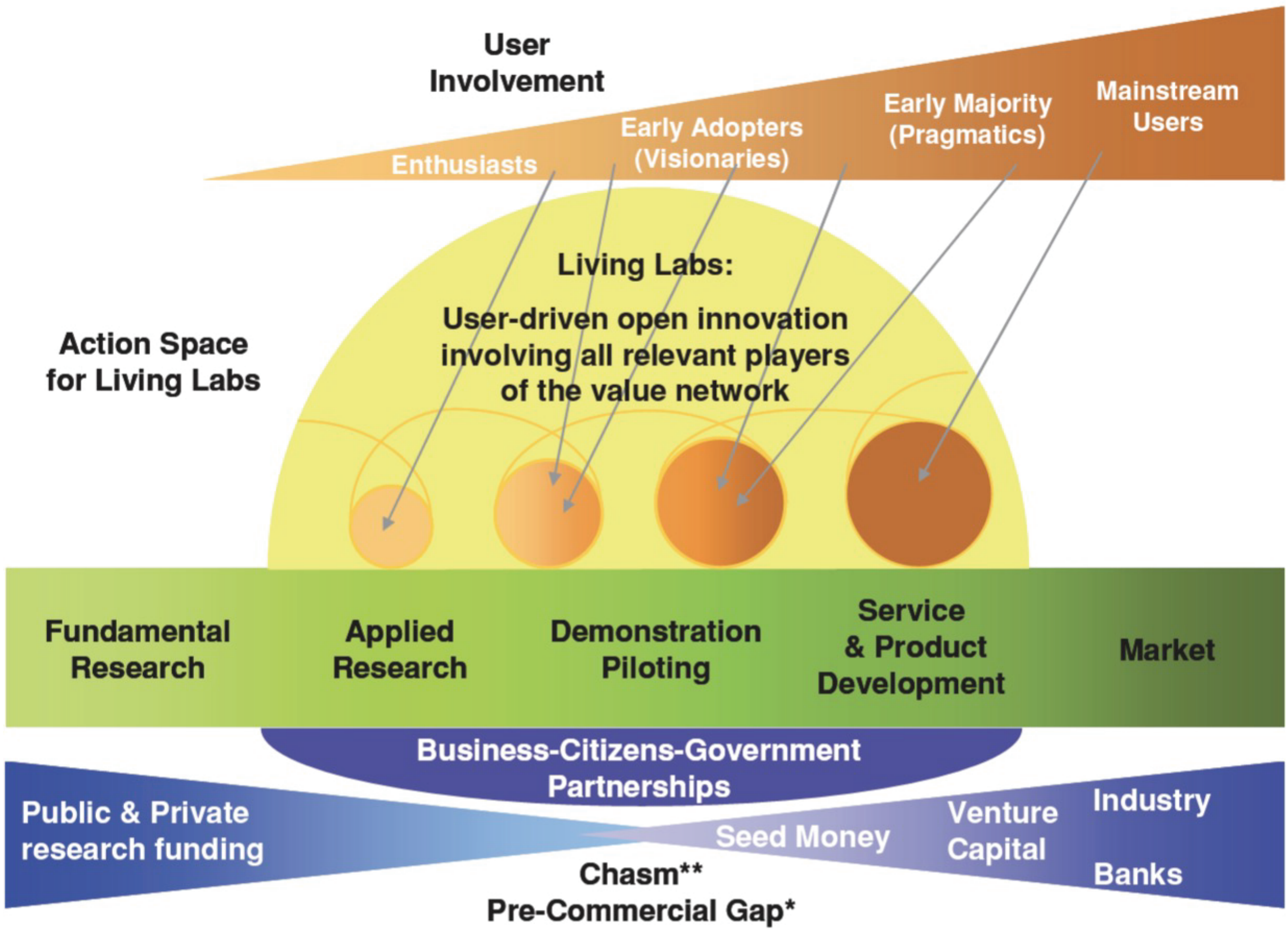
Customer relationship

It is very important to consider the customer relationship as part of the business strategy and evolution over time.
Th e implementation of good customer relationship allows a successful long term client satisfaction and market development.

The relationships that can be established with the customer vary over time:

- Initial contacts In this phase there is no real relationship, but there are mainly frequent contacts aimed at stimulating interest and generating leads;
- Feasibility study and development of a demo after the lead conversion, an initial collaboration relationship is established. This is aimed at validating (from a technical point of view) the possible application.
- In case of successful validation, a commercial relationship is established to define sales terms and for the adaptation, installation and fine tuning of the platform.
- After-sales service Once the platform has been integrated into the customer's production process, assistance in problem solving and maintenance of the platform will be offered.

Business model approach, Sustainability, and financial viability plan



Here below one possible classification of Living Labs

Scope	**Utilizer company-driven** Strategic R&D activity with preset objectives	**Provider driven** Strategy development through action	**Enabler driven** Solutions development through increased transfer of knowledge	**User driven** Problem solving by collaborative solutions
Structure	Network forms around a utilizer company, who organizes action for rapid knowledge results	Network forms around a region or a funded project	Network forms around an enabler organization(s)	Network based on users may lack formal coordination mechanisms
Activity	Utilizer guides information collection from the users and promotes knowledge creation that supports the achievement of preset goals	Information is collected and used together and knowledge is co-created in the network	Information is collected for immediate or postponed use; new solutions are based on the technologies that enablers get from the others	Information is not collected formallyand builds upon users' interest; knowledge is utilized in the network to help the user community
Outcomes	New knowledge for product and business development	Guided strategy changes into a preferred direction	New knowledge and solutions supporting market development	Solutions to users' every day-life problems
Timeline	Short	Short/Medium/Long	Short/Medium/Long	Long

Whatever taxonomy you will choose, it is important that you have a clear understanding of the type of LL that you want to set up, and its relation with your objectives,

Another version of typologies of LLs is the following:

- **Solution providers driven Living Labs (short-term and project-based):** Companies launching Living Labs to collect data on test-users of new products and services and to develop their businesses

- **Public authority-driven Living Labs (long term and transformative):** Public sector actors launching projects that pursue social innovation and improvements.

- **PPP-driven Living Labs (short-term project based or long-term transformative):** Public and private organizations launching Living Labs to co-develop new products, services and solutions by providing their network based on their portfolio and assets.

- **Citizens-driven Living Labs (long term transformative or project-based):** Citizens communities launching Living Labs to solve users' problems and develop a community of interest in the long term.

Anyway, it is a tenet of current concepts and models of LLs that co-creation is a relevant factor for the development of solutions, and that this approach shall be implemented with a recursive process.

Other approaches are anyway possible.

Living Labs usually operate as intermediaries/orchestrators among citizens, research organizations, companies & government agencies/ levels. Living Labs are open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact. They focus on co-creation, rapid prototyping and testing and scaling up innovations & businesses, providing (different types of) joint-value to the involved stakeholders.

Examples of different activities and processes by the LLs are the following:

- **Co-creation:** Brings together multiple stakeholders in a common landscape, ecosystem or process, where high-level questions meet different forms of technology push or social innovation potentials or urgent transition needs, and brings onboard a diversity of views, constraints and knowledge-sharing, which leads to a development of new scenarios and concepts. Co-creation should be introduced as early as possible in the process, and the focus and questions of the LL should be defined or refined and adjusted (if already given) in a co-creation process, engaging all the involved actors.

- **Exploration:** Engages all the stakeholders, who are identified as relevant first by the initiators of the actual LL, and then by the LL group members themselves. Especially user communities should be involved at the earliest possible stage of the co-creation process. Emerging scenarios, innovations and behaviors are explored through live scenarios, preferably in real-life environments.

- **Experimentation:** implements the proper level of technological artifacts or innovations 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 artifacts in real life situations through various dimensions, using data and making observations on the potentiality of a viral adoption of new concepts and related technological artifacts through a confrontation with users' value models.

The process typically consists of phases that involve multiple recursive steps.
This also depends on the maturity of the technology that you want to transfer, or to explore, or develop.
In such a process participate multiple actors with different roles.

Roles in the process:

It is advisable to clearly identify the role of the participants to the Living Lab activities and of all the sundry users and stakeholders involved.
This will allow you to ask specific contributions when needed and to properly ask questions and assign tasks.
Also, this definition of roles will allow you to identify possible gaps in the stakeholders and users in relation to the LL set-up and running of activities.
Here below we provide a tentative list, that you may use, or you may simply create your own definitions of the roles.
Nystrom et al., in their paper “Actor roles and role patterns influencing innovation in living labs” (Nyström, Leminen, Westerlund, & Kortelainen, 2014) have identified 17 roles of actors in living lab networks. **These include:**

1.Coordinator (coordinates a group of participants)
2.Gatekeeper (possesses resources)
3.Planner (participates in development process; provides intangible resources)
4.Messenger (forwards and disseminates information in the living lab network)
5.Integrator (integrates heterogeneous knowledge, development ideas, technologies, or outputs of different LL actors into a functional entity)
6.Contributor (collaborates intensively with other actors)
7.Webber (acts as the initiator, decides on potential actors)
8.Advocate (background role, distributes information externally)
9. Accessory provider (Self-motivated to promote its products, services and expertise)
10. Facilitator (offers resources for the use of the network)
11. Informant (brings users’ understanding & knowledge to the living lab)
12. Co-creator (co-designs a product, service, process)
13. Instigator (influences actors' decision-making processes)
14. Producer (contributes to the development process)
15. Builder (establishes and promotes the emergence of close relationships between various participants in the living lab)
16. Orchestrator (guides and supports networks activities; tries to establish trust to boost collaboration)
17. Tester (tests innovation in real life environments)

Classification of research technologies according to the level of development:

TRL Technology Readiness Level
In our TRANSDAIRY approach it is quite important to classify the technology identified as relevant, in our case for the scopes of the Dairy Value Chain.

The classification allows a selection of those that are suitable for reaching in a sustainable span of time the TRL9 and therefore will become available on the market before being outdated or outperformed by other commercial products by big players.

The status and maturity of a technology as well as each step of its development can be classified in terms of TRL Technology readiness Level in a scale from 1 to 9.

TRLs can be used to monitor the progress in the development path of your products, services, and technologies.

TRL 1 – basic principles observed
TRL 2 – technology concept formulated
TRL 3 – experimental proof of concept
TRL 4 – technology validated in lab
TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL 7 – system prototype demonstration in operational environment
TRL 8 – system complete and qualified
TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Here below we present an assessment tool for the TRL of a contrivance.

Technology Development Stage	TRL	Definition	Description	Methods	Checklist	Yes	No	Not Relevant
Fundamental research	1	Basic principles observed	Scientific research begins with properties of a potential technology observed in the physical world.	• Desk research • Interview • Survey • Observation	Basic research activities have been conducted and basic principles have been defined.			
					Principles and findings have been published in the literature.			
	2	Technology concept formulated	Applied research begins with identification of practical applications of basic scientific principles.		Applications of basic principles have been identified.			
					Applications and supporting analysis have been published in the literature.			
Research and development	3	Experimental proof of concept	Active research and development begin. The applications are being moved beyond the paper stage to experimental work.	• Co-creating workshop • Interview • Hackathon • Design sprint • Concept and feasibility testing	Proof of concept and/or analytical and experimental critical function has been developed.			
					Separate components have been validated in a laboratory environment.			
	4	Technology validated in lab	Basic technological components are integrated "ad-hoc" to establish that they will work together in a laboratory environment.		"Ad-hoc" integrated components, sub systems and/or processes have been validated in a laboratory environment.			
					It is understood how "ad-hoc" integration and test results differ from the expected system goals.			
					Semi-integrated component(s)/ subsystems or processes have been validated in a simulated environment.			
	5	Technology validated in relevant environment	The integrated basic technological components are performing for the intended applications in a simulated environment.		It is understood how the simulated environment differs from the expected operational environment and how the test results compare with expectations.			
Pilot and demonstration	6	Technology demonstrated in relevant environment	A model or prototype, that represents a near desired configuration, is being developed at a pilot scale, generally smaller than full scale. Testing of the model or prototype is being conducted in a simulated environment.	• In-house testing • Unit testing • Expert opinions • Usability testing • Integration testing • System level and large-scale piloting • Clinical trials	Pilot scale model or prototype is developed.			
					Pilot scale model or prototype system is near the desired configuration in performance, and volume but generally smaller than full scale.			
					Pilot scale prototype or model system has been demonstrated in a simulated environment.			
					It is understood how the simulated environment differs from the operational environment, and how results differed from expectations.			
	7	System prototype demonstrated in relevant environment	A full-scale prototype is being demonstrated in an operational environment but under limited conditions (i.e., field tests). At this stage, the final design is very close to completion.		Full-scale prototype with ready form, fit and function is developed.			
					Full-scale prototype demonstrated in an operational environment but under limited conditions.			
					Final configuration of the technology is developed.			
					Final configuration successfully tested in an operational environment.			
	8	System complete and qualified	Technology is being proven to work in its final form and under expected conditions. This stage commonly represents the end of technology development. At this stage, operations are well understood, operational procedures are being developed, and final adjustments are being made.		Technology's ability to meet its operational requirements has been assessed and problems documented; plans, options, or actions to resolve problems have been determined.			
Early adoption	9	Actual system proven in operational environment	Actual application of the technology in its final form is being conducted under a full range of operational conditions.	• Interview • Survey • Observation	The technology has been successfully deployed and proven under a full range of operational conditions.			
					Operational, test and evaluation reports have been completed.			
Commercially available		Technology development is complete	Technology is openly available in the marketplace and/or has been sold directly to a buyer in the public or private sector, in its current state or service offering for non-testing or development purposes.	• Interview • Survey • Observation	The technology is openly available in the marketplace and/or has been sold in its current state of service offering for non-testing or development purposes.			

How to ensure the Living Lab financial viability

The LL financial viability depends on the kind of living lab you are implementing, the kind of contrivances that will be supported and their stage of development.
Typically, a Living Lab is established with public fundings of limited duration.
This time span of 3-5 years will allow the consolidation of the activities and the creation of a network of interested parties and stakeholders.
How can the Living Lab survive and possibly flourish after that initial period?
Here multiple options are available.
Again, it depends on the scopes and on the level of maturity of the technologies you are developing or demonstrating.

In the TRANSDAIRY project the scope has been to make offer meet demand, and to implement support activities for further developments with vouchers for the creation of spin-offs and of patents.
So far, the spin-off and the owners of the new patents may benefit from the funding sources such as Crowd-funding, Seed Money, Venture Capital, Business Angels.
All of these options may ensure the viability of the newly created companies and the exploitation of their patents and IPR, but will not ensure the viability of the Living Lab.
One possibility is the Living Lab support for these steps being a paid service.
A more robust solution and possibly providing a regular funding for extended periods of time is to seek and find a big company, an industrial consortium, and similar entities that has consistent interests in the areas of technologies on which the LL is focused.
Such sponsors through the LL and its open collaborative platform can perform a wide range of activities to create exploitable innovation.

First a whole technology scouting, but also further development and testing of promising technologies that they can later on buy, exploit on license, or become a financial associate of the spin-offs.

Of course, there is always the option of obtaining public funding when your scopes are superimposed or have intersection to those of a public administration, a regional government policies etc.

This is typically the case of LLs that are focused on urban mobility or such sensitive social themes that are currently mainstream.

The possible revenue sources are:

- Financial sources
- Public funding
- Private funding
- Other approaches: offer of paid services

Business Model financial data: economic data five years projections

A sound preliminary quantification of the Living Lab economical feature over the five year time period is the way to understand the viability of your prospective Living Lab.

It is needed to consider need of:
- Initial investment (public funding, private funding from investors, big players, banking and other Foundations /organizations, NGOs)
- Potential market
- Different subcategories of the potential market
- Evolution of the potential market over time

The financial data are typically presented in a table spanning the five-year periods.
Such a table includes automatic formulas that allow testing different hypothesis.

The following table shows a typical example for commercial services and/or products that may be duly adapted to the type of sources of revenue of the Living Lab.

MARKET

		Year 1	Year 2	Year 3	Year 4	Year 5
Overall Potential market						
New potential customers per year						
Source of revenue Subcategory A						
Source of revenue Subcategory B						
Source of revenue Subcategory C						
Source of revenue Subcategory D						
		Year 1	Year 2	Year 3	Year 4	Year 5
Europe						
USA and Canada						
China						
Estimated Market Share: EU	(%)	0.10%	0.50%	1.00%	1.50%	2.00%
Estimated Market Share: USA and Canada	(%)	0.00%	0.10%	0.50%	1.00%	2.00%
Estimated Market Share: China	(%)	0.00%	0.00%	0.10%	0.40%	0.80%
Estimated Market Share: EU	Product or service sold	21	104	209	313	418
Estimated Market Share: USA and Canada	Product or service sold	0	11	55	110	220

	Estimated Market Share: China	Product or service sold	0	0	40	160	320
SALES FORECAST							
	Paid Services/products	#	21	115	304	583	958
INVESTMENT							
	Capital Investment	(€)					
	COST BREAKDOWN						
PRODUCTION COSTS	Production Cost per/device						
	Device A	(€)	4000	3980	3960	3941	3921
	Detailed costs						
	No. of man hours for annual service/device implementation	h					
	Manufacturing Salaries- Integration (Annual Payroll)	(€)					
	Manufacturing Salary - integrator cost per Device	(€)					
	Manufacturing Overheads per Unit	(€)					
	Firmware Development:	(€)					

	Yearly Junior Developer cost						
	Firmware Development and Update: Yearly IT Supervisor cost	(€)					
	Firmware cost per Year (Salaries)	(€)					
	Firmware Salaries per Device	(€)					
	Salaries for engineers and sales managers	(€)					
	Salaries for engineers and sales managers per Device	(€)					
	Labor Cost per Device	(€)					
	OpEx						
	Insurance	(€)					
	Accounting and Legal	(€)					
	Utilities	(€)					
	Certificates maintenance (CE Marking and maintenance of other certs)	(€)					
	Equipment	(€)					
	Maintenance and Service	(€)					
	OpEx per service/Device	(€)					
MARKETING	Marketing						
	Marketing Budget	(€)					
	Marketing Cost Per Service/Device	(€)					

SALES	Sales						
	Total cost per service /device	(€)					
	SALE PRICE	(€)					
	Wholesale price of service/device	(€)					
	Retail Price	(€)					
CASH FLOW	EARNINGS AND CASH FLOW						
	Total revenue	(€)	**€1,020,170**	**€4,726,114**	**€11,754,078**	**€21,864,292**	**€35,747,434**
	Cost of Goods Sold	(€)	€321,805	€941,798	€2,163,723	€3,960,092	€6,348,024
	Gross Profit	(€)	€698,365	€3,784,316	€9,590,355	€17,904,200	€29,399,411
	Selling, General Administrative Expenses	(€)	€109,770	€96,942	€110,766	€171,052	€231,346
	Earnings before interest, taxes, depreciation & amortization (EBITDA)	(€)	€588,595	€3,687,374	€9,479,589	€17,733,148	€29,168,064
	Depreciation and Amortization	(€)	€130,000	€130,000	€150,000	€150,000	€150,000
	Earnings before interest and taxes (EBIT)	(€)	€458,595	€3,557,374	€9,329,589	€17,583,148	€29,018,064
	FINANCIAL INDEXES						
	Income Taxes (21%)	(€)	€96,305	€747,048	€1,959,214	€3,692,461	€6,093,794
	Net operating profit after tax	(€)	€362,290	€2,810,325	€7,370,376	€13,890,687	€22,924,271
	Cash Flow	(€)	-€157,710	€2,940,325	€7,420,376	€14,040,687	€23,074,271
	Net Present Value (Rate 6%)	(€)	€38,849,745				

Return on total investment	(€)	68.99 %	134.66%	128.38%	128.89%	128.25%
Return on Capital	(%)	35.79 %	100.00%	98.66%	100.00%	100.00%
PROFITABILITY RATIOS						
Gross Margin	(%)	68.46 %	80.07%	81.59%	81.89%	82.24%
Net Profit Margin	(%)	35.51 %	59.46%	62.70%	63.53%	64.13%

Plan to Scale-up and multiplier effect

There are several definitions of scaling up. The concept comes from manufacturing, meaning the aim to grow and economies of scale (Gabriel, 2014). The term has been used especially in the health sector – in addition to the increase of service provision or outcomes, it has also been used for describing the increase or more efficient usage of inputs (budgets or workforce) and for scaling small projects to wider audiences.

Scaling up can be smooth, stepwise or a great leap (WHO, 2008). The WHO Expand Net defines scaling up as: “deliberate efforts to increase the impact of successfully tested… innovations… to benefit more people...”. (WHO, 2010)3.

According to the lean startup approach for startups, scaling up means reaching a point where the company aims at rapid growth. At this point, the company has reached a product/market fit, and both the company and the investors have the same goal – growth.

Therefore, precisely this point is a convenient time to raise additional funding (Jureen, 2014; Maurya, 2010).

Phases of a successful path to scale up:

1.Problem/solution fit: Find out whether there is a problem that is worth solving, that customers are willing to pay to be solved, and that can be feasibly solved. Validate the problem and the solution with real potential customers and end-users. This is a bootstrapping stage financed by friends, family and angel investors.

2.Product/market fit: Test the solution and its ability to solve the problem with a minimum viable product (MVP) released to the market. The MVP includes a minimal set of features for solving the core problem. The results lead to pivot or persevere: change or keep the MVP. The goal of this phase is to test if a) the customer is willing to pay for the product, b) there is an economically viable way to get customers, and c) the market is large enough. This is the seed stage, in which a startup often works in an accelerator or incubator and gets its first paying customers.

3.Scale: Build organizational structures, turn startup into a corporation. This is the customer creation and growth phase with venture capital funding.
This phase starts once the solution has been proven good enough for the masses, thus evolving from minimum viability to a scalable product.

4.Preparations for scaling up: Sketching a scalable business model with Lean Canvas because the environment is uncertain and startups have no history, writing lengthy traditional business plans is not sensible.

Therefore, presenting the business model in a one-page visual representation has become a popular approach for startups. A business model describes how a company creates and delivers value to its customers and captures a market share so that the business model becomes economically sustainable.

Some examples of the important issues related to the end-users or user organizations and required actions to increase the potential for a scaling up success are the following:

- Strengthening need or motivation through advocacy using formal and informal channels
- Identifying, working with and mobilizing advocates or champions who are ready to speak for the innovation (lead users, etc.)
- Identifying any opposition to the innovation, and trying to reduce it
- Identifying areas where implementation capacity is stronger
- Strengthening the implementation capacity by offering support for implementation (training of end-users or personnel, etc.)
- Advocating for needed policy or legal changes
- Identifying possible negative impacts and finding ways to prevent them
- Maximizing opportunities and minimizing constraints of changes required for implementation.

In terms of Living Labs scaling up has been intended as the wider adoption of a Living Lab developed solution. This does not necessarily imply the sale of a product.

For example, a living lab developing sensors for air quality and pollution monitoring, after having tested the sensor positioning them on the roof of its own building, then reaches an agreement with the town government that finances a new set of sensors to be positioned on the roofs of many public buildings.

In terms of the TRANSDAIRY living lab model scaling up is intended in different ways.

TRANSDAIRY Living Labs included activities to develop a business plan for technologies or products related to the Dairy Value Chain or to spin-offs, or patents.

The TRANSDAIRY Living Labs did not involve technologies, products, processes suitable for scale up in collaboration with public administrators for the adoption of technologies, such as in smart cities living labs.

In the TRANSDAIRY model the scale-up refers to the core activities of the Living Lab:

- Increase the demand of innovative technologies by stakeholders i.e. increase the mapping of their needs and expectations across the five helix and along the value chain. Also increase their awareness of the possibilities offered by the Living Lab to make their demand public. also increase awareness that expressing their demand is valuable.
- Increase the offer of innovative technologies
- Increase the encounter of demand and offer
- Increase the support activities for the creation of start-ups and for Patents.
- Increase the training activities

On the other side, you may want to support the offered technologies/spin-offs in the development of a business model for products or services that were part of the activities you supported.
Such a business plan may also include a scalability plan. These plans were developed in the TRANSDAIRY project as part of WP5; output 5.6.