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Living labs and innovation platforms:

A literature review

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About the Knowledge, Technology and Innovation research group at Wageningen University & Research

The Knowledge, Technology and Innovation (KTI) research group is uniquely positioned at Wageningen University & Research (WUR), given the importance of knowledge, technology and innovation in societal transformations across WUR domains of food, health and environment. We offer an interdisciplinary environment, actively seeking collaboration with groups in other life science domains and contributing to the university's ambition to improve the quality of life. We engage with diverse international networks of scholars and house a community of international PhD candidates, many of whom come from the Global South.

About WorldFish

WorldFish is a leading international research organization working to transform aquatic food systems to reduce hunger, malnutrition and poverty. It collaborates with international, regional and national partners to co-develop and deliver scientific innovations, evidence for policy, and knowledge to enable equitable and inclusive impact for millions who depend on fish for their livelihoods. As a member of CGIAR, WorldFish contributes to building a food- and nutrition-secure future and restoring natural resources. Headquartered in Penang, Malaysia, with country offices across Africa, Asia and the Pacific, WorldFish strives to create resilient and inclusive food systems for shared prosperity.

About Communication, Participation & Social-Ecological Learning

Communication, Participation & Social-Ecological Learning (CoPSEL) is a transdisciplinary research group at Van Hall Larenstein University of Applied Sciences. It focuses on transition processes for sustainable futures by exploring communication and participation processes and social-ecological learning in regional, national and international contexts. CoPSEL works in arenas of knowledge co-creation and participatory and deliberative governance in configurations such as living labs, where the private sector, civil society, knowledge institutions and government collaborate. Applying a perspective of experience capitalization highlights the group's interest in documenting and sharing outcomes of knowledge creation in societal, professional and academic spaces.

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1. Introduction

This literature study identifies the success and failure factors of living labs and innovation platforms. The study accomplishes this by zooming in on key characteristics and design principles of living labs and innovation platforms and distilling statements from academic and professional literature. Design principles are guidelines to follow in the design process to implement and operate a living lab or innovation platform successfully.

The literature review strategy was as follows:

1. First, various definitions of living labs and innovation platforms were collected from the literature. This literature search was not systematically conducted. Diverse literature was checked for definitions and analyzed to identify several key characteristics of living labs and innovation platforms. The key characteristics were then clustered into themes to construct a frame for the remaining part of the literature review.
2. In the next step, relevant literature was selected in Scopus. This search was systematically conducted and based on a chosen search string, which is explained in section 3.1.
3. In the third step, the selected literature was analyzed to identify design principles within each cluster of key characteristics.

Additionally, all selected literature, including the abstracts and DOIs, were added in two sections.
An appendix was added as a note on the role of WorldFish in living labs.

2. Key characteristics of living labs and innovation platforms

In this section, we first provide definitions for living labs and innovation platforms, highlighting key aspects of the definitions. To emphasize that definitions are dynamic and develop over time, we present them in order of year of publication.

After a short review of the definitions, we then identify key characteristics of living labs and innovation platforms.

2.1. Definitions of living labs

- "A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values" (Bergvall-Kåreborn et al. 2009:3).
- "physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes and users, all collaborating for creation, prototyping, validating and testing of new technologies, services, products and systems in real-life contexts" (Veeckman 2013:7).
- "It considers living labs as innovation networks characterized by openness and user involvement, suggesting that living labs provide an emerging research perspective on innovation networks" (Nyström et al. 2014:483).
- "A Living Lab is an orchestrator of open innovation processes focusing on co-creation of innovations in real-world contexts by involving multiple stakeholders with the objective to generate sustainable value for all stakeholders focusing in particular on the end-users" (Ståhlbröst *In* Malmberg and Vaittinen 2017:5).
- "A Living Lab is a multi-stakeholder organization set-up to carry out innovation projects that follow the principles of open and user innovation and focus on real-life experimentation" (Schuurman *In* Malmberg and Vaittinen 2017:5).
- "A Living Lab is a place where citizens, artists, technologists, businesses and public sector organisations can come together to co-create ideas, tools and technologies that will address local challenges. It's a place for innovation and exploring new possibilities but where reflection and evaluation are built into the working process to make sure the Living Lab can be flexible and responsive to the changing needs of stakeholders and communities" (Evans *In* Malmberg and Vaittinen 2017:5).
- "For me a Living Lab is a creative space where people with many different interests and backgrounds can collaborate in new and imaginative ways. Living Labs are also creative spaces for sharing technical skills and technical spaces for sharing creative skills. This makes Living Labs very special places" (Carter *In* Malmberg and Vaittinen 2017:5).
- "Living labs can be described as a methodology of innovation that enables collaborative learning by users, producers and researchers in a real-life environment, in which user-needs are central (Almirall et al., 2012; Del'Erra and Landoni, 2014; Leminen et al., 2014, 2015; Schuurman *In* Malmberg and Vaittinen 2017)" (Van Geenhuizen 2018:1280).
- "user-focused experimental environments in which users and producers co-create innovative solutions in real-life settings" (Kim et al. 2020:55).
- "Living labs are described as experimental settings for public innovation different from the traditional, more controlled, internally driven environments of public innovation (see, for example, Ruijer and Meijer 2020). They are seen as a 'collaborative platform for research, development, and experimentation in real-life contexts, based on specific methodologies and tools, and implemented through specific innovation projects and community-building activities' (Gascó 2017:91). They involve users as co-creators of innovation (Schuurman and Tõnurist 2017). Innovation can be understood as the development of something new and its realization in practice (Fuglsang 2010)" (Fuglsang et al. 2021:58).

- "Living Labs (LLs) are a mechanism or approach that brings a diversity of stakeholders together to arrive at user-centric solutions and innovations and thus they could present a viable method for solving complex issues" (Bronson et al. 2021:2).
- "open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact" (ENoLL n.d.).
- "Living labs catalyse the development of user-centric solutions for complex environmental issues by exploring, co-creating, testing, and evaluating innovations within real-world contexts" (Beaudoin et al. 2022:1).

2.2. Definitions of innovation platforms

- "The concept of 'innovation platform' refers to a set of stakeholders bound together by their individual interests in a shared issue, objective, challenge or opportunity, dealing with which will improve livelihoods, enterprises and/or other interests" (FARA *In* Sanginga et al. 2007:382).
- "The leverage points for making a significant difference in an innovation platform lie mostly in the interaction between the different components or actors in the system, rather than in strengthening any one component on its own. A well-functioning and complete innovation platform would organize all relevant players, including farmers and their organizations, extensionists and their organizations, researchers and their organizations, higher learning institutions, civil society organizations and the private business sector in ways that facilitate the sharing of ideas, technology and learning" (FARA *In* Sanginga et al. 2007:382).
- "An Innovation platform (IP), which serves as the platform for diagnosing problems, exploring opportunities and investigating solutions. An Innovation Platform is the framework which brings stakeholders along the value chain together for continuous interaction lessons learning through action research to ensure that technology generation, dissemination and adoption takes place on targeted commodities or systems for the economic benefit of stakeholders. This kind of platform can be enhanced [by] the use of information and communication technology including [the] internet" (Adekunle and Fatunbi 2012:983).
- "An innovation platform is a space for learning and change. It is a group of individuals (who often represent organizations) with different backgrounds and interests: farmers, traders, food processors, researchers, government officials etc. The members come together to diagnose problems, identify opportunities and find ways to achieve their goals. They may design and implement activities as a platform, or coordinate activities by individual members" (Homann-Kee et al. 2013:1).
- "Innovation platforms are equitable, dynamic spaces designed to bring heterogeneous actors together to exchange knowledge and take action to solve a common problem" (Cadhilon 2013:1).
- "In the field of AR4D, IPs form an important element towards more structural and long-term collaboration and engagement between stakeholders in the agricultural sector that has been indicated as essential to achieve development impacts" (Schut et al. 2016a:1–2).
- "Innovation platforms (IPs) engage key actors in dominant networks for multi-stakeholder learning to explore changes that could be of common interest" (Schut et al. 2016a:2).
- "An innovation platform is a physical or virtual space, or series of events, whose purpose is to support the development of new ventures" (Van Fossen et al. 2018:609).
- "An Agricultural IP is a space for interaction where agricultural stakeholders collectively identify agricultural challenges and develop solutions" (Dondofema and Grobbelaar 2020:421).
- "IPs are spaces for learning, action and change, where groups of individuals (or organisations) with different background, expertise and interests engage to diagnose problems, identify opportunities and find ways to achieve their goals" (Marais et al. 2020:106).

- "Innovation platform refers to a space where stakeholder groups with different (expertise and) interests can collaboratively define and redefine problems, learn together and develop and scale actionable solutions to these problems" (Edlmann and Grobbelaar 2021:6).
- "Innovation platforms [for public innovation] are dynamic learning environments (physical or virtual places) with and for actors, enabling governments to transform themselves and adapt to new challenges" (Cárdenas et al. 2021:115).
- "Multistakeholder Platforms can be seen as a form of 'innovation network-level interventions' (Klerkx et al., 2012: 471) and can be defined as 'arenas of joint learning' (Ros-Tonen et al., 2015: 534). They are usually initiated by action researchers, with engagement of farmers, NGO representatives, policymakers, extension officers, traders, processors and retailers, to jointly diagnose problems, identify opportunities, and combine scientific and local knowledge to undertake action with the aim being to effect change (Cullen et al., 2014; Ros-Tonen et al., 2015). 'Joint learning', also referred to as 'social learning', can be defined as 'a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks' (Shaw and Kristjanson, 2014: 2686). By combining different kinds of knowledge and joint learning, new knowledge can be 'co-produced' or 'co-created' (Akpo et al., 2015; Struik et al., 2014). Through knowledge co-creation in a multi-stakeholder setting, MSPs aim at changing certain behaviour, practices, policies or institutions or improving livelihoods for farmers, often the main target groups of the interventions" (Van Ewijk and Ros-Tonen 2021:1–2).

Value chain focused:

- "An IP is a physical or virtual forum established to facilitate interactions and learning among stakeholders selected from a commodity chain leading participatory diagnosis of problems; joint exploration of opportunities and investigation of solutions leading to promotion of agricultural innovation along the targeted commodity chain. Functionally, IPs operate at two levels: the strategic and the operational platforms" (Adekunle et al. 2010:2).
- "A physical, virtual, or physico-virtual network of stakeholders which has been set up around a commodity or system of mutual interest to foster collaboration, partnership and mutual focus to generate innovation on the commodity or system" (Adekunle and Fatunbi 2012:983).
- "A forum for learning and action involving a group of actors with different backgrounds and interests: farmers, agricultural input suppliers, traders, food processors, researchers, government officials, etc. These actors come together to develop a common vision and find ways to achieve their goals. They may design and implement activities as a group or coordinate activities by individual actors" (Swaans et al. 2013:118).

Inclusive focused:

- "Innovation platforms (IPs) (also referred to as multi-stakeholder platforms, innovation networks or learning alliances) are forums that are designed to bring together stakeholders from different interest groups, disciplines, sectors and organizations to exchange knowledge, ideas and resources and take action to solve common problems in order to bring about a desired change. The combination of these different actors is seen as a potential catalyst for addressing problems within a given system, and a way of ensuring that various groups – including those traditionally marginalized from innovation – can contribute to the change process" (Cullen et al. 2014:260).

2.3. A review of the definitions

Even though we are using the concept of living lab as one entity, disentangling both parts of the concept is required to explore the diversity of definitions. The word *lab* immediately assumes a connection with experimentation and research, as it abbreviates *laboratory*. And *living* indicates a reference to experimentations occurring outside laboratory walls, out in "the real world" addressing contemporary or actual issues. In addition, *living* also connotes movement. It refers to dynamic and flexible processes in continuous flux and development. Kim et al. (2020) define living labs as "user-focused experimental environments in which users and producers co-create innovative solutions in real-life settings."

Living labs are, therefore, environments in which actors come together to co-create sociotechnical configurations. These actors can go beyond solely producers and users and can include policymakers, knowledge institutes, researchers, "citizens, artists, technologists, businesses and public sector organisations" (Evans *In* Malmberg and Vaittinen 2017:10) and others who participate in the co-creation processes. Living labs are "physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) ... in real-life contexts" (Veeckman 2013:7). Living labs exist in many different sectors and address various topics.

In living labs, it is not necessarily only solutions for problems that the stakeholders work on. Living labs can also accelerate social innovations and improve quality of life in general. Some projects or programs emphasize the research component of a living lab by explicitly defining it as a research environment but at the same time acknowledging the integration with innovation in a real or daily life setting. Research-focused living labs are thus one particular type of living lab. *The Living Lab Methodology Handbook* identifies different types of living labs: "1. Research Living Labs focusing on performing research on different aspects of the innovation process, 2. Corporate Living Labs that focus on having a physical place where they invite stakeholders (e.g. citizens) to co-create innovations, 3. Organizational Living Labs where the members of an organization co-creatively develop innovations, 4. Intermediary Living Labs in which different partners are invited to collaboratively innovate in a neutral arena, and, 5. A time limited Living Lab as a support for the innovation process in a project. The Living Lab closes when the project ends" (Malmberg and Vaittinen 2017:6).

Following different authors, we can distinguish between a living lab as (1) an environment or milieu and (2) a methodology or approach. A living lab can first be seen as an "innovation eco-system" in a real-life context. The (open) system idea is often captured with the terms environment or milieu. It is also often defined as a(n innovation) platform. Basically, a living lab then refers to a physical or virtual setting where various actors collaborate to innovate (Veeckman 2013).

A second and a different perspective is to frame a living lab as a way of managing a multistakeholder innovation process. Central in this management process is collaboration with, the participation of and the focus on the end-users. Another characteristic of the living lab approach is the interactivity, the iterative cycle of activities focusing on social innovations. Such innovations also depart from more or less articulated considerations of diversity aspects influencing the living lab as a configuration or coalition between different parties.

A much-followed definition is provided by the European Network of Living Labs (ENoLL). ENoLL defines living labs as "open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact" (ENoLL n.d.:X) and sees the concepts of co-creation, multimethod approach, real-life setting, multistakeholder participation and active user involvement as central in the functioning of living labs (ENoLL n.d.).

The definitions of innovation platforms emphasize the created space and characterize the space as equitable, dynamic, physical or virtual, a series of events, a forum, a space for learning and change (a dynamic learning environment or an arena for joint learning), a leverage point for interaction possibly enhanced with information and communication technologies (ICTs). A shared interest in an issue binds individuals and groups with different knowledge and interests. Stakeholders are seen as key actors in dominant networks or in a commodity chain. An innovation platform can thus be seen as a system of mutual interests in which those traditionally marginalized can be included.

Innovation platforms focus on the following:

- Jointly define problems and solutions / solve a common problem / challenges and solutions / adapt to challenges / joint exploration of opportunities and investigation of solutions / solve common problems in order to bring about a desired change / develop a common vision and find ways to achieve their goals / explore changes that could be of common interest.

- Together exchange knowledge and take action / multi-stakeholder learning / joint learning for action and change / facilitate interactions and learning / co-production / co-creation knowledge / social learning / exchange knowledge, ideas and resources / sharing ideas, technologies and learning.
- Design and coordinate implementation of activities / foster collaboration, partnership and joint focus / ensuring that various groups (including those traditionally marginalized from innovation) can contribute to the change process / more structural and long-term collaboration and engagement.
- Ensure technology generation, dissemination and adoption / create new practices, discourse and behavior / policies and institutions / actors transform themselves and adapt to challenges / develop and scale solutions / develop new ventures / promote innovation along the targeted commodity chain / achieve development impacts.

We can conclude that part of the living lab definitions refers to real-life experimentation with the inclusion of and engagement with end-users for validation and feedback at the local level. In contrast, another part of the definitions aims at innovation. The innovation platform literature does not refer to real-life experimentation but emphasizes that innovation platforms are physical or virtual places for knowledge exchange and learning about problems and possible solutions. Innovation platforms tackle technical, organizational and policy issues requiring action at higher administrative levels (where testing is not an option). Half of the definitions for innovation platforms include sharing resources and coordinated management of action for change. The Dutch Rathenau Institute (Van den Broek et al. 2020) states that the impact of living labs in their focus on contextualization may insufficiently go beyond the level of "local enthusiasm." The authors indicate that a major strategy for impact realization requires proportional attention to all dimensions of innovation processes: technological, economic, legal and sociocultural (Van den Broek et al. 2020). Such a system view links the concept of responsible innovation with dimensions of anticipation, reflexivity, inclusion and responsiveness (Stilgroe et al. 2013).

While living labs test, validate and get feedback, monitoring and evaluation of innovation platform activities (notably impact at the strategic institutional or policy level) is difficult and rarely done. More monitoring of impact, performance and reflexivity for further action is advocated but not yet common practice. Schut et al. (2016b) note that in CGIAR, most innovation platforms focus on technical issues but tend to ignore institutional or policy change, which is essential for scaling. Furthermore, the inclusion of private actors is troublesome as their time is precious. However, they have much knowledge of consumers and trends and are essential for out-scaling.

2.4. Key characteristics

Based on the analysis in sections 2.1–2.3, we identify and outline the key characteristics in Table 1.

These characteristics are clustered into three themes:

1. setting and system
2. stakeholders and collaboration
3. approach, aim and focus.

Living labs	Innovation platforms
Setting and system	
The setting of a living lab is a real-life setting in which various stakeholders come together. A real-life setting means that space is created in an existing, practice-based situation where stakeholders act based on their stakes. A living lab is seen as a whole in which system characteristics are valued. Keywords include integration, system perspective, wholeness and holism, ecology, embeddedness, contextualization, milieu and environment.	The setting of an innovation platform is a physical and/or virtual space for interactive exchange and learning. A forum is created for stakeholders of a value chain or "system of interest" to meet and learn about common problems, explore solutions, coordinate action for change (and assess performance and outcome). Innovation platform literature recognizes that an innovation platform is an open system: the shape and composition of an innovation platform (who should be in to represent diverging interests and/or be capable of creating change) depend on the biophysical, sociocultural and institutional/political context.
Stakeholders and collaboration	
A living lab involves various stakeholders and focuses specifically on user participation. Keywords include inclusivity, trans-disciplinarity, diversity, equity, (end)users, multistakeholder, partnerships, and a quadruple helix framework of university, industry, government and public. Collaboration is another key characteristic of a living lab. The participating stakeholders collaborate in a way that best fits the functioning of the living lab. Keywords include collaboration, interaction, leadership, management, coordination and connectivity.	The definition of an innovation platform refers to a representation of stakeholders of an issue-of-interest or value chain. One definition refers to key actors of networks, while those definitions that focus on inclusive innovation note that those usually marginalized should also contribute. Their needs are leading. Collaboration for the exchange of knowledge, ideas and resources is key. All definitions highlight knowledge sharing or joint learning, and in time more definitions embrace the coordinated action for change.
Approach, aim and focus	
A living lab focuses on real-life experimentation with end-users for validation and feedback at the local level. The approach is thus characterized by experimentation, open innovation and co-creation. Keywords include learning, knowledge creation and sharing, ideation, research, testing, evaluating, experimentation, prototyping, validating, methodology, feedback, iterative cycle, life cycle approach and human-centered.	The aim is to solve a common problem by generating and scaling technical or business solutions; creating new practice, discourse, organization and institutions and policy; and transforming ourselves to take on new challenges. The objective is to (a) jointly define problems, opportunities, challenges and solutions/desired outcomes, and (b) to engage and coordinate action for change in practice, organizations/institutions and policies (operational and structural/long term). Evaluation of the complex non-linear learning, collaboration and change process is difficult and rarely done. Still, attempts are formulated to assess the attainment of envisaged goals and the functioning/performance of innovation platforms.

Table 1. Key characteristics of living labs and innovation platforms.

These three themes serve as a structure. Within each theme, we will identify design principles in relation to the key characteristics.

3. Relevant literature selected in Scopus

3.1. Selecting literature in Scopus

We selected Scopus as the primary database for identifying scientific publications. Scopus is a leading database for academic publications in the field of social sciences and, as such, includes the most relevant information concerning living labs and innovation platforms. Besides the systematic approach we followed to identify relevant literature, we also added literature that was already known to the authors. As we are familiar with the literature, we have prior knowledge of some relevant publications.

The following were the three steps used to select the literature:

1. The search string **"living lab" AND "literature review"** was used to identify living lab literature, and **"innovation platform" OR "multistakeholder platform" AND "literature review"** was used to identify innovation platform literature.
2. The search string **"principles" OR "guidelines" OR "handbook" OR "framework" AND "living lab" AND "failure" OR "success" OR "constraint" OR "effectiveness" AND "review" OR "evaluat*"** was then used to identify additional living lab literature and **"principles" OR "guidelines" OR "handbook" OR "framework" AND "multi-stakeholder platform" OR "innovation platform" AND "failure" OR "success" OR "constraint" OR "effectiveness" AND "review" OR "evaluat*"** to identify additional innovation platform literature.
3. Other literature was added that was not identified in the systematic literature search in Scopus but known to the authors.

3.2. Search results and selected literature

For living labs, the following search string was used: **"living lab" AND "literature review."**

Sixty-one documents were found using this string. Of those, the following 18 were selected after scrutinizing the abstracts:

Akasaka F, Mitake Y, Watanabe K and Shimomura Y. 2022. A framework for 'configuring participation' in living labs. *Design Science* 8:E28. doi: 10.1017/dsj.2022.22

Burbridge M and Morrison GM. 2021. A systematic literature review of partnership development at the university–industry–government nexus. *Sustainability* 13(24):13780. dx.doi: 10.3390/su132413780

Dekker R, Franco Contreras J and Meijer A. 2020. The living lab as a methodology for public administration research: A systematic literature review of its applications in the social sciences. *International Journal of Public Administration* 43(14):1207–17. doi: 10.1080/01900692.2019.1668410

Franz Y. 2015. Designing social living labs in urban research. *Info* 17(4):53–66. doi: 10.1108/info-01-2015-0008

Fuglsang L, Hansen AV, Mergel I and Røhnebæk MT. 2021. Living labs for public sector innovation: An integrative literature review. *Administrative Sciences* 11(2):58. dx.doi: 10.3390/admsci11020058

Greve K, Vita RD, Leminen S and Westerlund M. 2021. Living labs: From niche to mainstream innovation management. *Sustainability* 13(2):791. dx.doi: 10.3390/su13020791

Hossain M, Leminen S and Westerlund M. 2019. A systematic review of living lab literature. *Journal of Cleaner Production* 213:976–88. doi: 10.1016/j.jclepro.2018.12.257

Kim J, Kim YL, Jang H, Cho M, Lee M, Kim J and Lee H. 2020. Living labs for health: An integrative literature review. *European Journal of Public Health* 30(1):55–63. doi: 10.1093/eurpub/ckz105

Knight-Davidson P, Lane P and McVicar A. 2020. Methods for co-creating with older adults in living laboratories: A scoping review. *Health and Technology* 10(5):997–1009. doi: 10.1007/s12553-020-00441-6

Leminen S and Westerlund M. 2019. Living labs: From scattered initiatives to a global movement. *Creativity and Innovation Management* 28(2):250–64. doi: 10.1111/caim.12310

Lupp G, Zingraff-Hamed A, Huang JJ, Oen A and Pauleit S. 2020. Living labs: A concept for co-designing nature-based solutions. *Sustainability* 13(1):188. dx.doi: 10.3390/su13010188

Mbatha SP and Musango JK. 2022. A systematic review on the application of the living lab concept and role of stakeholders in the energy sector. *Sustainability* 14(21):14009. doi: 10.3390/su142114009

Pascu C and Van Lieshout M. 2009. User-led, citizen innovation at the interface of services. *Info* 11(6):82–96. doi: 10.1108/14636690910996731

Paskaleva K and Cooper I. 2021. Are living labs effective? Exploring the evidence. *Technovation* 106:102311. doi: 10.1016/j.technovation.2021.102311

Schäpke N, Bergmann M, Stelzer F and Lang DJ. 2018. Labs in the real world: Advancing transdisciplinary research and sustainability transformation: Mapping the field and emerging lines of inquiry. *GAIA - Ecological Perspectives for Science and Society* 27(1):8–11. doi: 10.14512/gaia.27.S1.4

Tercanli H and Jongbloed B. 2022. A systematic review of the literature on living labs in higher education institutions: Potentials and constraints. *Sustainability* 14(19):12234. dx.doi: 10.3390/su141912234

Thees H, Pechlaner H, Olbrich N and Schuhbert A. 2020. The living lab as a tool to promote residents' participation in destination governance. *Sustainability* 12(3):1120. dx.doi: 10.3390/su12031120

Zipfel N, Horreh B, Hulshof CTJ, de Boer AGEM and Van der Burg-Vermeulen SJ. 2022. The relationship between the living lab approach and successful implementation of healthcare innovations: An integrative review. *BMJ Open* 12(6):e058630. doi: 10.1136/bmjopen-2021-058630

With the search string **"principles" OR "guidelines" OR "handbook" OR "framework" AND "living lab" AND "failure" OR "success" OR "constraint" OR "effectiveness" AND "review" OR "evaluat*"** 19 additional articles on living labs were found. Of those, the following five were useful after scrutinizing the abstracts:

Äyväri A and Jyrämä A. 2017. Rethinking value proposition tools for living labs. *Journal of Service Theory and Practice* 27(5):1024–39. doi: 10.1108/JSTP-09-2015-0205

Burbridge M. 2017. If living labs are the answer – What's the question? A review of the literature. *Procedia Engineering* 180:1725–32. doi: 10.1016/j.proeng.2017.04.335

Mamba MSN and Isabirye N. 2015. A framework to guide development through ICTs in rural areas in South Africa. *Information Technology for Development* 21(1):135–50. doi: 10.1080/02681102.2013.874321

Marvin S, Bulkeley H, Mai L, McCormick K and Palgan YV, eds. 2018. *Urban Living Labs: Experimenting with City Futures*. London: Routledge.

Ondiek MA and Moturi C. 2019. An assessment of the sustainability of living labs in Kenya. *Innovation & Management Review* 16(4):391–403. doi: 10.1108/INMR-08-2018-0058

The following is an additional selection of literature on living labs:

Beaudoin C, Joncoux S, Jasmin JF, Berberi A, McPhee C, Schillo RS and Nguyen VM. 2022. A research agenda for evaluating living labs as an open innovation model for environmental and agricultural sustainability. *Environmental Challenges* 7. doi: 10.1016/j.envc.2022.100505

Bergvall-Kåreborn B, Eriksson CI, Ståhlbröst A and Svensson J. 2009. A milieu for innovation: Defining living labs. ISPIM Innovation Symposium, Vienna, Austria, December 6–9, 2009.

Bouwma I, Wigboldus S, Potters J, Selnes T, Van Rooij S and Westerink J. 2022. Sustainability transitions and the contribution of living labs: A framework to assess collective capabilities and contextual performance. *Sustainability* 14(23):15628. dx.doi: 10.3390/su142315628

Bronson K, Devkota R and Nguyen V. 2021. Moving toward generalizability? A scoping review on measuring the impact of living labs. *Sustainability* 13(2):1–16. doi: 10.3390/su13020502

Keyson DV, Guerra-Santin O and Lockton D. 2016. Living labs: Design and assessment of sustainable living. London: Springer International Publishing. doi: 10.1007/978-3-319-33527-8

Lapointe D and Guimont D. 2015. Open innovation practices adopted by private stakeholders: Perspectives for living labs. *Info* 17(4):67–80. doi: 10.1108/info-01-2015-0003

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Witteveen L, Eweg R and Smits T. 2016. Design principles for living lab's aiming at sustainable development: The role of higher education in living lab's. Competence 2016 Wageningen, Wageningen, the Netherlands, October 19-21, 2016. https://www.researchgate.net/publication/311456793

For innovation platforms/multistakeholder platforms the following search string was used: **"innovation platform" OR "multistakeholder platform" AND "literature review."**

Thirteen documents were found using this string. Of those, the following seven were selected after scrutinizing the abstracts:

Cárdenas LFS, Álvarez LVB, González YLV, Díaz-Piraquive FN and Silva HFC. 2021. Public innovation through co-creation platforms in response to the Covid-19 Pandemic. *In* Uden L, Ting I-H and Wang K, eds. *Knowledge Management in Organizations*. Cham, Switzerland: Springer International Publishing. 111–22. doi: 10.1007/978-3-030-81635-3

Dondofema R and Grobbelaar SS. 2020. Supporting innovation through a multi-level platforms approach: A case study of the South African fresh fruit industry. *African Journal of Science, Technology, Innovation and Development* 12(4):421–34. doi: 10.1080/20421338.2019.1681102

Edlmann FRP and Grobbelaar S. 2021. A framework of engagement practices for stakeholders collaborating around complex social challenges. *Sustainability* 13(19):10828. dx.doi: 10.3390/su131910828

Van Fossen K, Morfin J and Evans S. 2018. A local learning market to explore innovation platforms. *Procedia Manufacturing* 21:607–14. doi: 10.1016/j.promfg.2018.02.162

Marais A, Meyer I, Kennon D, Herselman M and Grobbelaar S. 2020. Supporting the formation and functioning of innovation platforms in healthcare value chains. *Science and Public Policy* 48:1–17. doi: 10.1093/scipol/scaa061

Van Ewijk E and Ros-Tonen MAF. 2021. The fruits of knowledge co-creation in agriculture and food-related multi-stakeholder platforms in sub-Saharan Africa: A systematic literature review. *Agricultural Systems* 186:102949. doi: 10.1016/j.agsy.2020.102949

With the search string **"principles" OR "guidelines" OR "handbook" OR "framework" AND "multi-stakeholder platform" OR "innovation platform" AND "failure" OR "success" OR "constraint" OR "effectiveness" AND "review" OR "evaluat*"** five additional articles on innovation platforms were found. Of those, the following three were useful after scrutinizing the abstracts:

Carroll GP, Srivastava S, Volini AS, Piñeiro-Núñez MM and Vetman T. 2017. Measuring the effectiveness and impact of an open innovation platform. *Drug Discovery Today* 22(5):776–85. doi: 10.1016/j.drudis.2017.01.009

Kobicheva A, Baranova T and Tokareva E. 2020. The development of an interaction mechanism between universities and other innovation system actors: Its influence on university innovation activity effectiveness. *Journal of Open Innovation: Technology, Market, and Complexity* 6(4):109. dx.doi: 10.3390/joitmc6040109

Schut M, Kamanda J, Gramzow A, Dubois T, Stoian D, Andersson JA, Dror I, Sartas M, Mur R, Kassam S et al. 2019. Innovation platforms in agricultural research for development: Ex-ante appraisal of the purposes and conditions under which innovation platforms can contribute to agricultural development outcomes. *Experimental Agriculture* 55(4):575–96. doi: 10.1017/S0014479718000200

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Adekunle AA, Fatunbi AO and Jones MP. 2010. How to set up an innovation platform: A concept guide for the Sub-Saharan African challenge programme (SSA CP). Accra, Ghana: Forum for Agricultural Research in Africa (FARA).

Adekunle AA and Fatunbi AO. 2012. Approaches for setting-up multi-stakeholder platforms for agricultural research and development. *World Applied Sciences Journal* 16(7):981–88.

Boogaard B, Klerkx L, Schut M, Leeuwis C, Duncan A and Cullen B. 2013. Critical issues for reflection when designing and implementing research for development in innovation platforms. Report for the CGIAR Research Program on Integrated Systems for the Humidtropics. Ibadan, Nigeria: CGIAR; Wageningen, the Netherlands: Knowledge, Technology & Innovation Group (KTI), Wageningen University and Research Centre.

Brouwer H, Woodhill J, Hemmati M, Verhoosel K and Van Vugt S. 2015. The MSP guide: How to design and facilitate multi-stakeholder partnerships. Wageningen, the Netherlands: Wageningen Centre for Development & Innovation (WCDI).

Cadilhon J. 2013. A conceptual framework to evaluate the impact of innovation platforms on agrifood value chains development. 138th EAAE Seminar on Pro-poor Innovations in Food Supply Chains, Ghent, Belgium, September 11–13, 2013.

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Hounkonnou D, Brouwers J, Van Huis A, Jiggins J, Kossou D, Röling N, Sakyi-Dawson O and Traoré M. 2018. Triggering regime change: A comparative analysis of the performance of innovation platforms that attempted to change the institutional context for nine agricultural domains in West Africa. *Agricultural Systems* 165:296–309. doi: 10.1016/j.agsy.2016.08.009

Hounkonnou D, Kossou D, Kuyper TW, Leeuwis C, Nederlof ES, Röling N, Sakyi-Dawson O, Traoré M and Van Huis A. 2012. An innovation systems approach to institutional change: Smallholder development in West Africa. *Agricultural Systems* 108:74–83. doi: 10.1016/j.agsy.2012.01.007

Kilelu CW, Klerkx L and Leeuwis C. 2013. Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme. *Agricultural Systems* 118:65–77.

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4. Design principles concerning key characteristics

Innovations created by living labs and innovation platforms are associated with certain challenges and risks. They can reinforce existing privileges, and minority perspectives could be neglected (Boogaard et al. 2013). Tokenism and poorly managed innovation platforms can break down trust and relationships and delay the implementation of interventions. Knowing who to engage at what point in time is not apparent, and ensuring the right representation and securing the right expertise for a particular innovation platform remain a challenge. Innovation platforms are resource-intensive and require careful assessment of the institutional context within which they function. Living labs and innovation platforms can both support innovation, but critical thought should be given to their functioning (Marais et al. 2020).

After having screened recent reviews and important key literature on living labs and innovation platforms, creating user-needed, equitable, social and ecologically sustainable, effective innovation, we identified and grouped the following critical design principles for the three themes: (1) setting and system, (2) stakeholders and collaboration, and (3) approach, aim and focus.

4.1. System and setting

4.1.1. Design principle 1: Think systemic

System thinking is central to the functioning of living labs and innovation platforms. Complex system thinking highlights the entwinedness of several dimensions of a problem: biophysical dimensions, links and feedback systems, as well as the links with and dynamics among different societal actors, their interests and perspectives. "Systemic" means "in relation to the whole system" (Brouwer et al. 2015). If we change one element, other parts of the system are affected and will respond. When creating change, it is necessary to look at the broader picture of biophysical dynamics as well as networks and relationships of stakeholders in the "system of interest" to define the root cause of a problem and identify actors relevant to tackle the problem (Van Ewijk and Ros-Tonen 2021).

Within the innovation literature, researchers tend to adopt different types of system thinking (Dondofema and Grobbelaar 2020; Edlmann and Grobbelaar 2021):

- Various researchers apply the value chain approach. In line with Porter (1985:2), they look at a service provision or production process in its entirety, from the input of raw materials to the final product. There are commodity value chains, but the value chain approach is also applied to service sectors, like Marais et al. (2020) did in studying the South African Health Care system. They noted that a value chain approach helps to understand the presence, role, nature, capabilities and competences of all actors within the healthcare value chain, including those poorly linked and marginalized, which is required to identify its major system challenges.
- Others apply the innovation-ecosystem approach, as it offers opportunities to investigate the dynamics of large production and innovation architectures, particularly with regard to the interconnected nature of stakeholders that influence innovation and the evolutionary nature of these stakeholder networks (Edlmann and Grobbelaar 2021).
- Most common is still the innovation system approach, which zooms in on actor networks explicitly collaborating on innovation. The common concept of an agricultural innovation system is defined as "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge" (Hall et al. 2006: vi–vii).

Whatever perspective is chosen, all agree that it is essential to know the larger system, its key actors and their relationships defining the evolution of development. Looking at the whole system makes it possible to identify technical, organizational and institutional problems, and select the appropriate systemic tool, like a type of living lab or innovation platform structure, as a setting apt to tackle the system problem.

4.1.2. Design principle 2: Generate an appropriate space

Although there is some overlap in the definitions for living labs and innovation platforms, the focus and structure of the setting for a living lab or innovation platform tend to differ somewhat. Living lab literature emphasizes the real-life setting for concrete experimentation, whereas innovation platform literature emphasizes the physical or virtual created space to support learning and action. This difference does not matter when we look at the core principle of the type of space to be created. A core driver for generating an appropriate space is that it should be safe. It should be a safe space enabling learning and acting. The created space should be dynamic to accommodate interactivity, mobility and movement.

Creating such a space requires organization and facilitation. Organization refers to logistics, like inviting people, managing costs, providing transportation and catering. Facilitation refers to managing the created space, determining strategies to create a safe space and implementing the strategies. Interactions, communications and learnings need to be facilitated by experienced facilitators. Depending on the system's characteristics, a type of systemic tool must be chosen. Van Fossen et al. (2018) distinguish three forms of settings with different values for innovation: (1) traditional incubators, (2) accelerators and (3) alternative innovation platforms.

1. Traditional incubators that offer low-cost workspace and services will be "enabling entrepreneurs and stakeholders to pursue risky technical and/or business experiments and learn quickly from consequent success or failures. Convening power, peer-to-peer networking, credibility and the provision of services to meet incubate needs (e.g., access to space, entrepreneurship knowledge, user market knowledge, entrepreneurial connections and networks, etc.) are identified as additional features of incubators. A number of objectives can be achieved through incubation, including rent generation, sales of services, entrepreneurial stimulation and growth, job creation, collaboration, knowledge transfer, research commercialization, and investment opportunity creation. Selection of incubatees should match the objectives of the incubator platform" (Van Fossen et al. 2018:8).
2. Accelerators are "a subset of incubators that aim to accelerate new venture creation by providing education and mentorship to cohorts of ventures during a limited time" (Van Fossen et al. 2018:9). Accelerators are set up to overcome shortcomings of traditional incubators. They tend to provide upfront investment, offer time-limited support in the form of workshops and intensive mentoring, cater to cohorts of startups rather than individual companies, and organize regular showcase days for customers and investors.
3. Alternative innovation platforms tackle other issues, such as organizational and institutional change and creating more conducive environments for innovation and transformation.

4.1.3. Design principle 3: Work in a context-sensitive way

Each living lab or innovation platform operates in a specific system, and each system functions in a particular context. Therefore, all living labs and innovation platforms operate in a specific social, cultural, economic and political context. Living labs are often locally embedded in a real-life situation and thus function in a particular local infrastructural, market and sociocultural setting. Innovation platforms not only function locally but may also target organizational and institutional change at higher system levels. Therefore, the structure and functioning of the platform need to be sociocultural and politically institutional sensitive (e.g. powerful high-level actors do not want to talk with low-level actors) and should be politically informed. In their systemic review of innovation platforms in developing countries, Van Ewijk and Ros-Tonen (2021) noted that, in most cases, an institutional change required the involvement of traditional authorities collaborating with district legislature and authorities at the national level.

To assess the need and opportunities for change for a living lab or innovation platform, it is essential to make an in-depth study of the context to identify (a) the real causes of emerging challenges, (b) the needs, interests and power positions of the direct stakeholders, especially the marginalized,

and (c) the potential key actors with authority and capabilities for change (Boogaard et al. 2013). This enables us to know whom to involve in the living lab or innovation platform for the design and implementation of simple small-scale changes of practices, and whom to involve and how for more complex transformative, systemic change (section 4.1.4). It is necessary to determine spaces for engagement, communication and creating a shared vision. Available resources among partners need to be identified and missing resources acquired. Hard and soft infrastructure impacts the extent to which innovation platforms can operate and influence policymaking. In short, the effectiveness and sustainability of living labs and innovation platforms depend on appropriate, context-relevant incentives to drive engagement and functioning (Marais et al. 2020).

4.2. Stakeholders and collaboration

4.2.1. Design principle 4: Facilitate stakeholder participation

Innovation platforms and living labs are particular partnership structures made up of multiple interacting stakeholders. Multistakeholder involvement means that groups of individuals (or organizations) with different backgrounds, expertise and interests engage. But whom should be included, and how and why, to create effective and appropriate innovation? This process of stakeholder participation needs facilitation (Mbatha and Musango 2022).

Facilitators play an essential role in strategic decision-making, whom to include, when and at what level. Living labs and innovation platforms need a good representation of the diversity of stakeholders and key actors who can make a difference. Still, the number of active participants must also be restricted to ensure dynamic teamwork. Some labs and platforms, therefore, work with periodic large multistakeholder workshops and small innovation teams, with a situational configuration apt to tackle specific innovation challenges at hand. The lab or innovation team membership is adapted according to the issue at stake, the stage of innovation, and the authority, skills and resources needed (Fichter and Beucker 2012). Depending on the innovation-ecosystem, it may be important to include actors from existing networks at the strategic (e.g. national), operational and grassroots levels (Dondofema and Grobbelaar 2020) to ensure sustainability and enforce change in an existing innovation ecosystem or create a new temporary lab or innovation platform structure to solve one specific issue (Fichter and Beucker 2012).

Strategic partnerships are also key to mobilizing capacities and resources for innovation. In partnerships, key actors such as universities, industry, government and nongovernmental organizations (NGOs) collaborate based on commitments that are formalized to a certain extent, using complementary resources and competences for market-based or public innovation (quadruple helix framework). It allows them to create innovation where individual actors cannot (Marais et al. 2020). Dekker et al. (2020: 1214) also emphasize the following: "Clearly define the role of each partner in the living lab and apply methods of process management to the implementation of the living lab to ensure productive collaboration and mutual trust."

Innovation platforms and living labs are founded on their inclusive approach to stakeholder participation. Stakeholders' expectations will differ, and the balance between fair representation and the inclusion of powerful key actors is delicate. Power dynamics need to be known and addressed at the project's outset. To evade a mismatch, such as stakeholders working to achieve different things and subsequent frustrations, it is crucial to define a common goal, clear roles and responsibilities early in the process and enforce them (Marais et al. 2020). Learning and capacity building around partnering can help establish the right balance for societal justice and effective and more sustainable functioning (Van Ewijk and Ros-Tonen 2021).

4.2.2. Design principle 5: Configure participation of users

"The Living Lab approach is commonly defined as 'user-centred,' which means that persons making use of a solution or innovation or benefitting from it are continuously engaged throughout the process" (Lupp et al. 2021:8). The literature overwhelmingly emphasizes the involvement of users. However, their participation needs to be configured. Participation is vital in various phases of the design process of living labs and innovation platforms. "The term 'configuring

participation' here refers to designing the process of participation in design, in other words, the configuration of the participation experience itself" (Akasaka et al. 2022:4/21). Akasaka et al. (2022) identified various key elements for configuring participation and clustered them in the categories phase, participants, format, contact and motivation management. User-centered design and configuring users' participation is a key concept in living lab constructions. User involvement is a central characteristic of living labs, while multistakeholder demand-driven innovation is critical to innovation platforms. User involvement enables working in a demand-driven way and facilitates identifying essential issues and disseminating outputs (Marais et al. 2020).

User involvement must be configured. Cárdenas et al. (2021) identified the following five challenges for citizens as users to participate in digital innovation platforms for public or government innovation:

1. **Challenge of scale**: How can the government hear citizens' voices and their diversity, and how can they be involved?
2. **Challenge of capabilities**: How to ensure constructive deliberation of citizens on public issues?
3. **Challenge of coherence**: How to consult, analyze and give feedback to the diversity of citizen voices?
4. **Challenge of evaluation**: How to mediate between government/public and diverse citizen objectives? What aspects are vital in this process?
5. **Challenge of commitment**: How to ensure citizen participation is taken seriously in public policy?

4.2.3. Design principle 6: Build rapport and govern responsibly

Collaborative work cannot do without trust and willingness to share data (Beaudoin et al. 2022). Building rapport takes time and is based on trust. Nyström et al. (2014) see building rapport based on trust as the role of the *builder*. "By supporting trust building mechanisms, the builder establishes and promotes the emergence of close relationships between participants such as users and companies in the living lab" (Nyström et al. 2014:486). The building role is one of the seven roles they identify in innovation networks. The collaborative process needs to be governed responsibly: An exchange of knowledge and interests related to the issue at stake, coupled with shared learning and experimentation, is fundamental to develop a sense of ownership and buy-in. A joint vision, clear division and coordination of tasks alongside recognitions of contributions ensure that labs or innovation platforms function smoothly and effectively and that actors are intrinsically motivated. And last but not least, accountability and transparency are important to maintain trust and commitment (Marais et al. 2020).

Edlmann and Grobbelaar (2021) executed a literature review on the engagement practices needed for multistakeholder action. They distinguished three categories of themes, critical for the formation and innovation process management:

1. Key for building rapport and engagement is stakeholder management. Communication for common understanding, conflict management, management of gender and racial dynamics, management of power dynamics, transparency and trust-building are all key for building rapport and engagement (Dondofema and Grobbelaar 2020; Edlmann and Grobbelaar 2021). Clear ground rules for respectful communication, confidentiality and voluntary participation, and a skilled, experienced facilitator are pivotal to attain this (Marais et al. 2020).
2. When these base conditions are created, the facilitator and the participants can focus on the innovation tasks, such as strategic representation and network functioning, visioning and planning, structured process facilitation, monitoring and evaluation, and the respectful rolldown of participation when goals are met (Boogaard et al. 2013; Edlmann and Grobbelaar 2021).
3. If everything is managed well, this will lead to joint work on the desired outcomes, such as knowledge sharing, alignment, participation and championing of action, resource mobilization and experimenting, and shared learning.

All these themes are interconnected, so the performance of the different themes influence each other and therewith the engagement along the process (Edlmann and Grobbelaar 2021). Living labs and innovation platforms go through life cycles and stages with different governance needs. In time, innovation capacity and self-governance are built, but can be disrupted when new challenges emerge (Boogaard et al. 2013). Depending on the context and issue at stake, the living lab or innovation platform builds up formal and informal relations and procedures for innovation and scaling, or finishes the task at hand and dissolves, recognizing the contribution of the team/network (Edlmann and Grobbelaar 2021).

4.3. Approach, aim and focus

4.3.1. Design principle 7: Co-create

As with the innovation platform literature, the living lab literature stresses the centrality of the principle of co-creation. Fuglsang et al. (2021), as well as many others, identify co-researching and co-creating innovation with users and stakeholders as a core characteristic in various types of living lab environments. Co-creation concerns planned interactive processes to trace the system-specific and context-sensitive direction of change and define possible solutions. Creativity and design are key in these processes, which are almost always long term (Cárdenas et al. 2021). In living labs and public-private partnerships, scientific research does not always have an explicit role. Still, in many innovation platforms, co-creation is closely linked to an action research methodology (Van Ewijk and Ros-Tonen 2021). Action research concerns open collaboration between scientists and societal stakeholders in iterative cycles of observation, reflection and action.

In innovation platform literature, the terms "meaningful dialogue" and "visioning" are often used to establish a consensus on the values, goals, overall intervention, its components and implementation (Boogaard et al. 2013; Marais et al. 2020). The knowledge management process should incorporate local values and knowledge into the dialogue to identify appropriate visions and solutions (Marais et al. 2020). It seems the first motivation and positive mood for collaboration and co-creation depend primarily on the alignment of short- or medium-term visions and gains, leaving room to tackle the divergence of long-term visions at a later stage (Edlmann and Grobbelaar 2021).

Knight-Davidson et al. (2020) explore methods for co-creating with older adults in living labs through a scoping review of the literature. They concluded that "methods of co-creation with older adults in this review suggest that co-creation might be viewed as 'legitimate' even when there is low involvement of older adults in the design/development process; however, inclusive methods that involve end-users from the early stages of design (or concept) are regarded as most conducive with needs finding and effective co-creation" (Knight-Davidson et al. 2020:1007).

4.3.2. Design principle 8: Innovate through reflexivity

Innovation is key to innovation platforms, and the core of living labs is experimenting and testing designed change, products and services in a real-life setting. Operating in dynamic environments renders it necessary for living labs and innovation platforms to be open and act flexibly to adapt rapidly to changes while focusing on the search process (Marais et al. 2020). Therefore, continuous support for experimentation and entrepreneurial activity, as well as guidance in the search, is necessary.

Together, monitoring the process, regular user feedback and evaluation can ensure the guidance of the search and innovation capacity building. Schut et al. (2018) and Van Ewijk and Ros-Tonen (2021) note that most studies of innovation platforms provide little insight into the interventions' contribution to the platform's functioning and impact. This means process monitoring and evaluation is not structurally executed. It is challenging, as an interplay of factors characterizes specific innovation processes, and certain aspects are difficult to track. However, it is important to monitor the process, create momentum, celebrate success and share what did not work well to maintain motivation and learn how to be effective (Boogaard et al. 2013; Van Ewijk and Ros-Tonen 2021). In this context, Fuglsang et al. (2021) review how methodologies of living labs are addressed and understood in the literature.

A living lab entails iterative testing and feedback (Hossain 2019). This immediately reveals the central role of reflexivity. Through experimentation and reflection, innovation becomes better understood. Reflexivity is also fundamental because of the open character of the process. An open approach to innovation and change requires continuous monitoring, evaluation and adjustment. User-driven innovations require a willingness to adapt methods and continuous reflective learning (Knight-Davidson et al. 2020).

Being reflexive allows people to act more in accordance with their changing environment and, in this way, to increase the chances of influencing learning for innovation and transformation positively. As highlighted by Beers and Van Mierlo (2017:417), "Reflexivity is a human (group and/or individual) capacity, that may be present to a varying extent, and which can be supported and enhanced." It is helpful to reflect on and improve one's ability to recognize, interact and affect the living lab's or innovation platform's dynamics, as well as the discourse, relationships and/or procedures in the institutional setting.

4.3.3. Design principle 9: Engage with scale and impact

A systemic review of how innovation platforms function in Africa (Van Ewijk and Ros-Tonen 2021) revealed that most platforms' knowledge sharing, experimentation and collective learning induced changes in farm practices at the local level, while others reported increased access to markets, higher production income and better farmer livelihoods. The results on poverty alleviation were mixed, but there was ample evidence of improved environmental sustainability. Apart from these concrete outcomes, researchers, planners and policymakers learned how to engage better with multiple stakeholders. The systemic review also showed that most innovation platforms still primarily operate locally and might overlook organizational and institutional change needed at a higher level to support scaling (Van Ewijk and Ros-Tonen 2021). Schut et al. (2016a) underscore the same issue and the need to simultaneously work on a bundle of related technical/economic, organizational and institutional issues at different scales.

As mentioned in section 2.3, some living labs and innovation platforms are temporary, project-initiated structures set up to tackle a specific issue, but several authors highlight the need for more durable structures. Formal, long-lasting innovation structures embedded in existing innovation ecosystems have more time and means to enforce necessary organizational and institutional changes needed for scaling and impact. A central problem of existing innovation platforms is their reliance on project-based donor funding, which constrains their structural embeddedness and impact (Van Ewijk and Ros-Tonen 2021).

Fuglsang et al. (2021) cluster the outcomes of living labs under four headings: (1) administrative values that focus on the improvement of administrative processes, (2) citizen values that aim to improve the relationship between public administrations and citizens, (3) societal values that improve transparency, accountability and responsibility for the sake of the larger society and (4) economic values that improve how public administrations deliver services, save costs and generally become more efficient and effective. Hossain et al. (2019:985) make a distinction of the outcomes of living labs in two different ways: "(i) tangible and intangible innovation and (ii) a diversity of innovation. However, some outcomes may be tangible and intangible based on their contexts."

To somehow get a grip on impact, Bouwma et al. (2022:1) developed "an assessment framework that enables the capturing of the dynamic role and contribution of living labs," and Van Geenhuizen (2018) developed a framework for the evaluation of living labs as boundary spanners in innovation, while Bronson et al. (2021) conducted a scoping review on measuring the impact of living labs.

5. Conclusion

One thing that the literature review proved is that innovation platforms, and especially living labs, are trending. The overwhelming amount of publications in the past few years demonstrates a collective interest and a remarkable enthusiasm for them. As the definition exercise in this literature review revealed, the key concepts and the core ideas behind innovation platforms and living labs seem to be more or less clear. They aim to generate systemic settings where stakeholders collaborate, co-create and innovate to reach particular objectives.

Although we are starting to get a grip on the functioning of living labs and innovation platforms, there is still a lot to learn about how to make them operate responsibly and successfully. This literature review added to this learning by identifying nine design principles. The assumption is that adhering to these principles will contribute to the success of living labs and innovation platforms.

The nine design principles:

System and setting
Design principle 1: Think systemic
Design principle 2: Generate an appropriate space
Design principle 3: Work in a context-sensitive way

Stakeholders and collaboration
Design principle 4: Facilitate stakeholder participation
Design principle 5: Configure participation of users
Design principle 6: Build rapport and govern responsibly

Approach, aim and focus
Design principle 7: Co-create
Design principle 8: Innovate through reflexivity
Design principle 9: Engage with scale and impact

Appendix 1. Note on the role of WorldFish in living labs

In line with the One CGIAR strategy, the Resilient Aquatic Food Systems for Healthy People and Planet (AqFS) program aims to achieve positive, measurable benefits across five impact areas: (1) nutrition, health and food security, (2) poverty reduction, livelihoods and jobs, (3) gender equality, youth and social inclusion, (4) climate adaptation and mitigation, and (5) environmental health and biodiversity. As many technological and methodological innovations are developed but hardly used, AqFS wants to create or support effective aqualabs (partnerships and working methods) to identify, evaluate, pilot and scale technologies and institutional innovations in line with the five impact areas and appropriate for a given context. The literature review elaborated on key characteristics of effective, inclusive living labs and innovation platforms. Still, the question remains: what role should an international organization such as WorldFish take to instigate or enhance effective aqualab functioning and embeddedness in local innovation systems (be it government-, NGO- or private actor-driven innovation systems)?

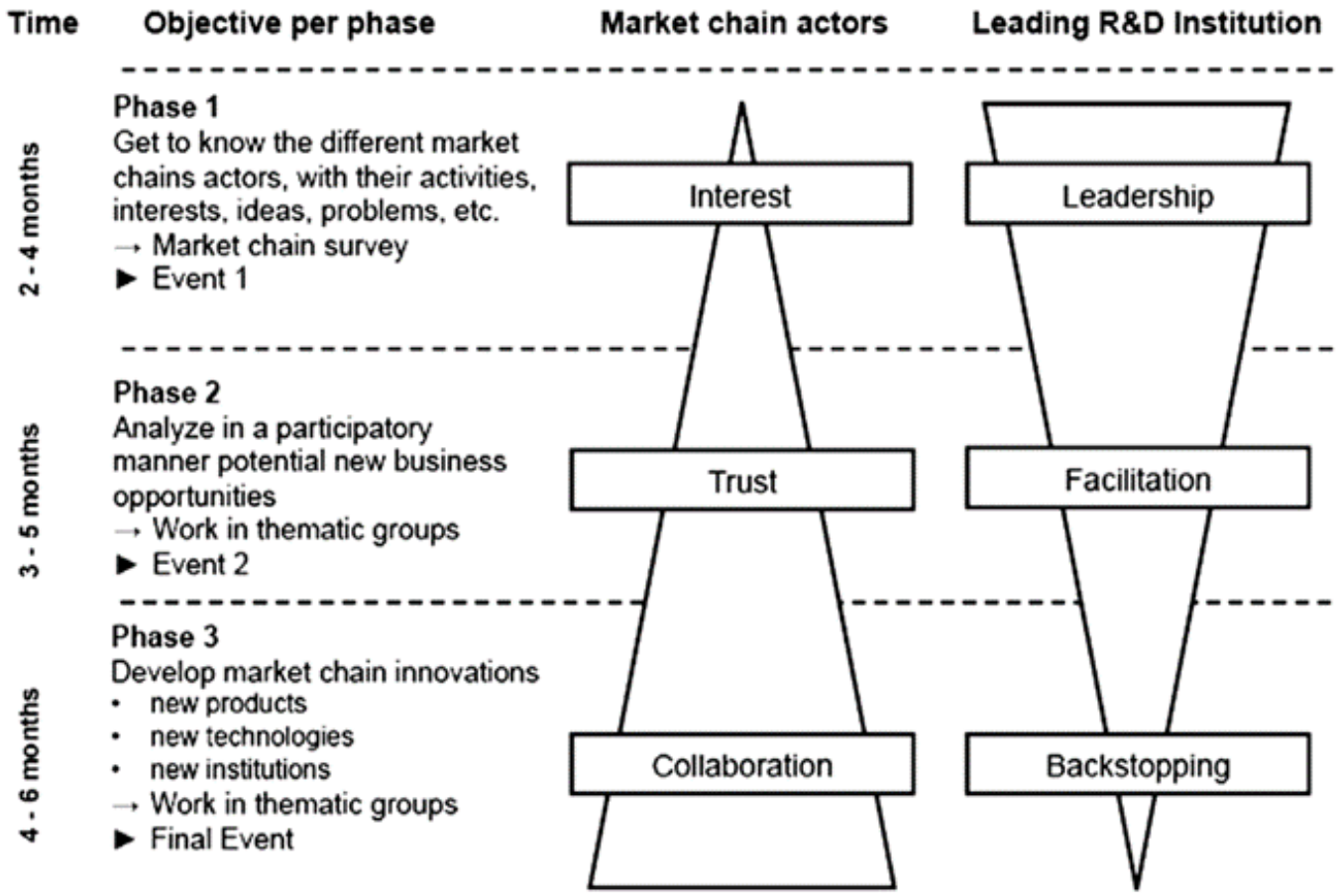
Based on the literature review and the various experiences of the authors, we have added this short note on the role of WorldFish in living labs. Role-taking in living labs is an active and deliberative process that requires positioning and reflection throughout all (iterative) stages of living lab dynamics, especially for partners with enabling and facilitating roles. This note concerns the type of role (or multiple roles) different actors can take in living labs. It addresses how actors change their role in time to enhance lab functioning to pursue their interests better or reciprocally adjust to the role enacted by others (Heikkinen et al. 2007; Nystrom et al. 2014). Moreover, it touches upon the role WorldFish could take on to ensure local embeddedness, dynamism, ownership and capacity building.

Distribution of roles

The literature review has surfaced two detailed elaborations of roles (network management and innovation tasks). Annex 1 shows the roles of living labs as elaborated by Heikkinen et al. (2007) and Nyström et al. (2014), and Annex 2 shows the roles for innovation networks elaborated by Kilelu et al. (2011). Kilelu et al. (2011) elaborate on an innovation intermediary as an "organisation formally engaged in coordinating and facilitating innovation processes between two or more parties" (Kilelu et al. 2011:89). This characterization is important here for its reference to WorldFish and related aqualabs to articulate the importance of the dominant position a CGIAR member may have or be attributed. Nyström et al. (2014) studied the role patterns of actors in a living lab from different role theory perspectives. Their findings highlight that actors first tend to perform the roles pre-set by the structural position they take in a network, but in time they use their capacities and resources to (temporarily) change roles.

The findings of Nyström et al. (2014) align with Tuckman's model of group development, which highlights different stages of group leadership, trust and relationship building, and task performance (Halverson and Tirmizi 2007; Bonebright 2010). Action-oriented theories for team development and participatory innovation capacity building (Tennyson and Wilde 2000; Devaux et al. 2009; Schut et al. 2017) underscore the importance of situational leadership, with clear guidance on the aim, appropriate composition and rule-setting at the start, followed by a progressive delegation of tasks, accompanied by facilitation of group performance and commitment through coaching, backstopping, and monitoring and evaluation for learning. Building on the interests of actors, such a participatory approach would create trust and effective collaboration among actors for innovation (Figure 1).

Although relevant for the elaboration on situational leadership, the approach suggests sequential phases, which might be a characteristic of innovation processes compared to living labs, where the vision is, by definition, not a clearcut focus on a tangible innovation. Imperial et al. (2016) use the concept of "healthy and useful life" to contrast a term like "success" in describing a network process and further elaborate on the stages of network development. A fine-grained analysis of specific accountability tasks in different stages resonates with the diversity of roles presented by Kilelu et al. (2011). It is functional in clarifying roles of reflexive accountability for enabling living lab partners.



Source: elaborated by Devaux et al. (2009) based on Bernet et al. (2006).

Figure 1. Different phases of a participatory innovation approach.

In this context, Edlmann and Grobbelaar (2021) executed a systematized literature review explicitly focused on the engagement of actors in innovation and distinguished between three types of practices:

1. **Concrete engagement practices**, such as communication, conflict management, management of gender and racial dynamics, managing power dynamics, transparency and trust building, are executed by the actor-network itself.
2. **Enabling practices** ensure effective and fruitful interactions within and around a network toward leveraging the specific innovation goals. These practices concern the use of oversight structures and practices, monitoring and evaluation, flexible roll down or adding of actors to ensure a manageable innovation team with the capacity to enforce the envisaged innovation, strategic representation of the diversity of stakeholders in the network, and the regular visioning and reflexivity for responsive decision-making.
3. This then leads to desired **outcome practices**, such as alignment of network actors, championing progress innovation, implementation, appropriate participation, and shared learning for capacity building.

What role for international research institutes?

Schut et al. (2016) noted that many international research for development organizations, such as the members of CGIAR, are still tempted to use living labs and innovation platforms mainly to outscale available technological innovations rather than to act user-driven and facilitate innovation at a local level while also creating a conducive environment at the institutional level. Therefore, structural education of research for development professionals, proper embedding of living labs and innovation platforms, visioning and reflexive guidance of the actor-network processes were recommended as critical elements for inclusive stakeholder-led innovation and systemic change (Schut et al. 2016a). As a member of CGIAR, WorldFish is

well positioned to create and guide embedded living labs and innovation platforms that engage and build their capacity for more demand-led, inclusive and systemic change. Their role would be

- **to make a (participatory) network analysis** of existing labs and innovation networks, their relations and functions, to engage embedded networks and actors needed for a living lab or innovation platform with the desired focus (Schiffer and Waale 2008; Schiffer and Hauck 2010);
- **to provide clear leadership and guidance** at the start of the living lab or innovation platform on the vision, composition and process rules and delegate active network management of task roles as soon as possible (Tennyson and Wilde 2000; Devaux et al. 2009; Schut et al. 2017), and focus on "enabling engagement practices" as identified by Eldmann and Grobbelaar (2021) (Annex 3).

The enabling engagement practices help (i) keep the focus on the vision, (ii) have the appropriate lab or platform composition, with actors able to create the envisaged change, (iii) monitor the process and outcome for reflexive learning about the impact of one's activities and how to reorient to become more successful. If done in a participatory mode, the ownership remains with local actors, who build their capacity "by doing." In this process, it is crucial to ensure complementary tasks such as methodological training and lobbying at the policy level for more widespread structural change, providing conducive environments and space for the lab or platforms to function appropriately and effectively (Seifu et al. 2020).

The context in which living labs and innovation platforms are established and need to function are complex, dynamic and uncertain. As a consequence, every organization involved, and especially every organization involved in overarching enabling activities, needs to be reflexive and flexible. Taking this into account, and to be able to align the various roles and ensure appropriate, efficient and effective functioning, we have identified some role-taking principles.

Role-taking principles

Whatever role an actor takes on, there are a couple of points to consider. These points relate to how the role is fulfilled according to defined policies assigned in the brokering process resulting from resource-providing and other enabling tasks. As in the literature review, these points are underlying principles. We have selected the following:

- **Be explicit**: It is important that the roles of actors are made explicit and are part of agenda setting. This means that decisions have to be made on who takes on which role, and if roles are combined, the interaction of the combined roles should also be explicated. Being explicit directly relates to being accountable, which concerns accepting responsibility for one's role.
- **Be transparent**: The division of roles must be clear to everybody involved. From the start of a living lab, it must be transparent which actors take on which roles. Transparency directly relates to trust. Transparency is about what others see as the truth.
- **Be sensitive**: Being sensitive requires continuous monitoring of the functioning of the living lab. This concerns all actors involved. All actors are responsible for the overall functioning of a living lab. Any interferences or disturbances should be made explicit and transparent with a culturally sensitive attitude.
- **Be reflexive**: Being reflexive goes beyond being reflective. All actions should be reflected upon, but being reflexive goes further in the sense that these reflections should be explicit and transparent about and sensitive to the underlying assumptions, cultural differences, political values, power dimensions and other biases. Being reflexive is essential for the efficient functioning of being explicit, transparent and sensitive.
- **Be flexible**: Being explicit, transparent, sensitive and reflexive immediately results in flexibility. If the actor's role that is taken on is open and up for discussion, one must be flexible in adjusting and adapting.

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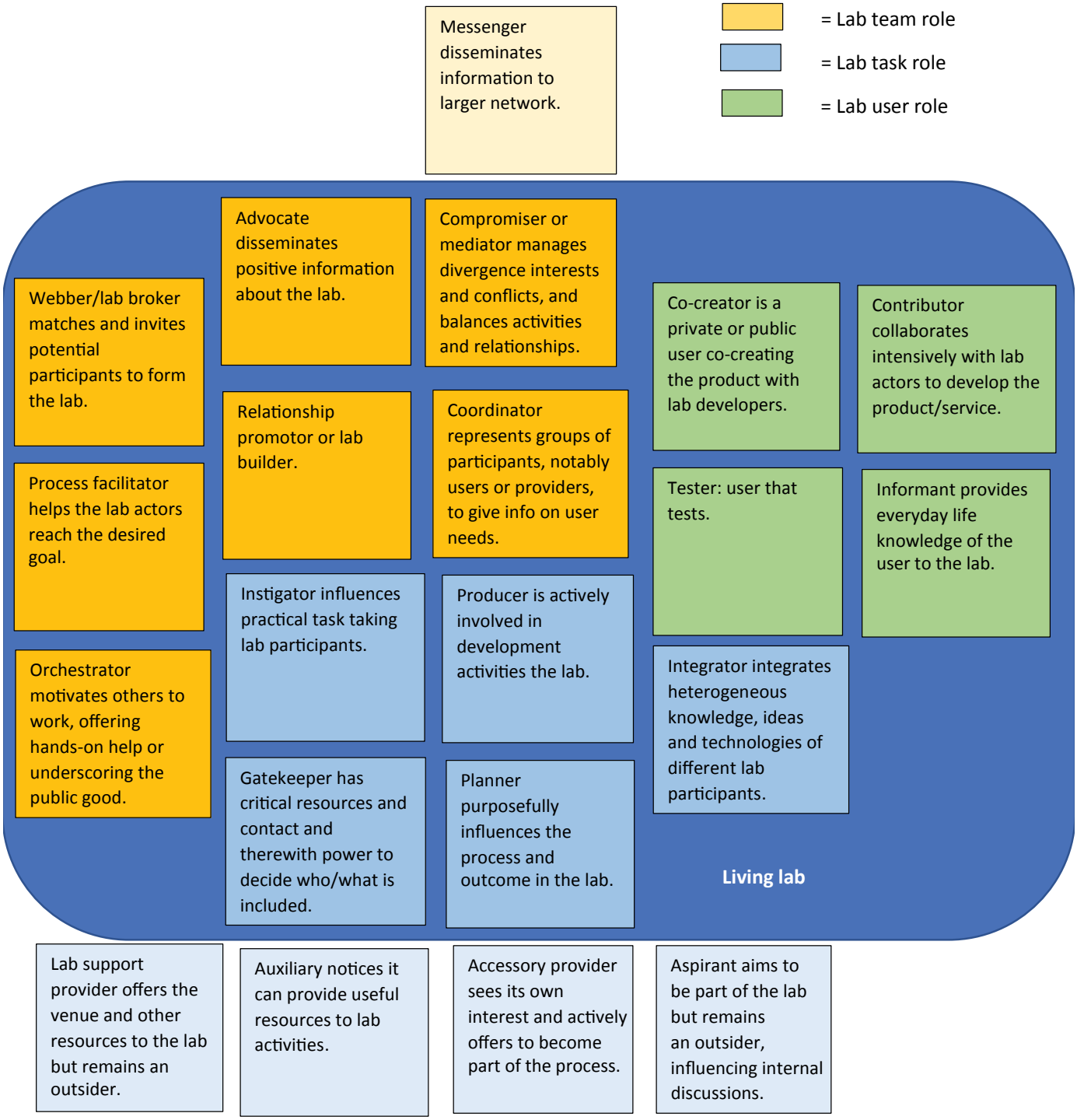
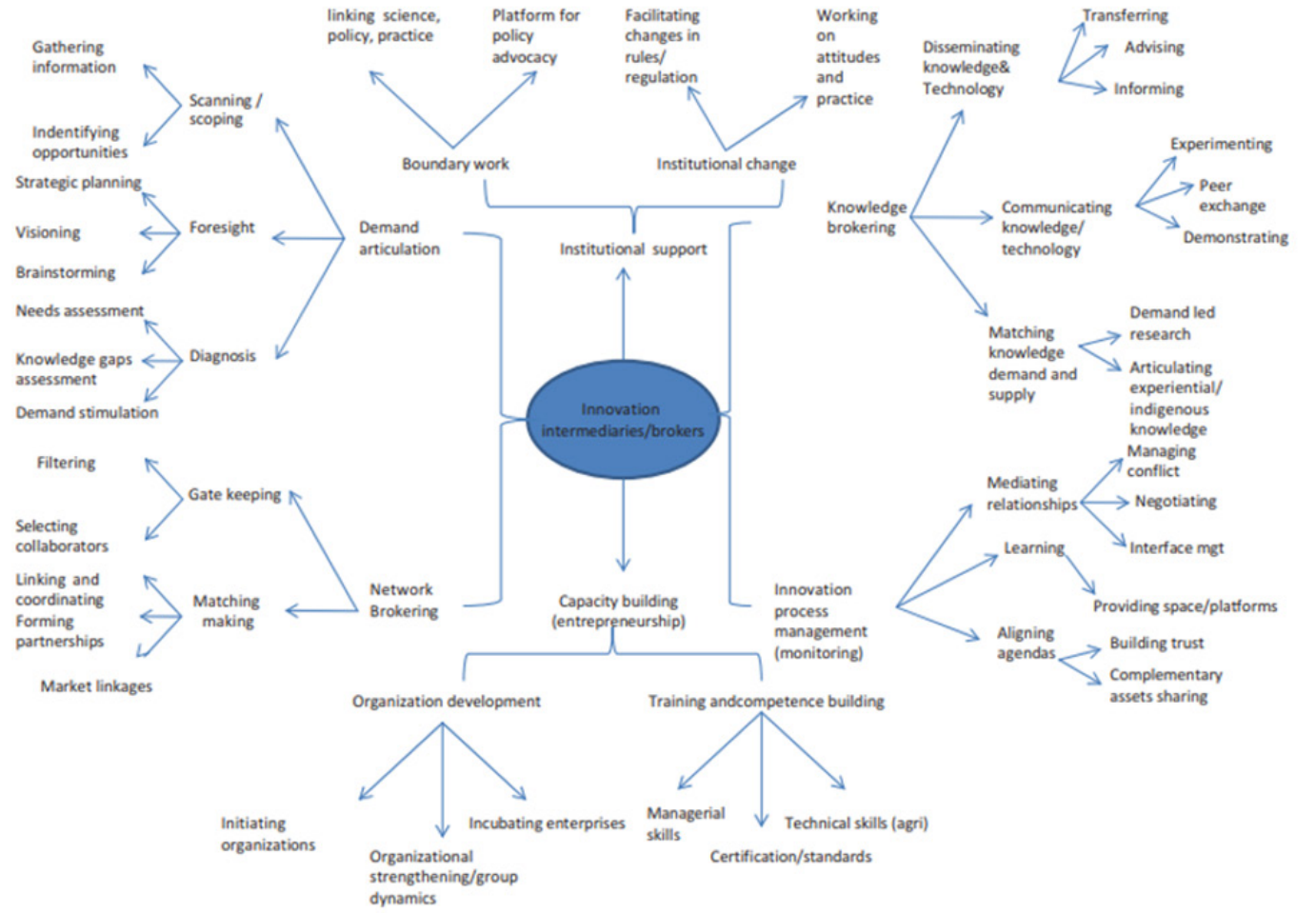
Annex 1. Living lab roles



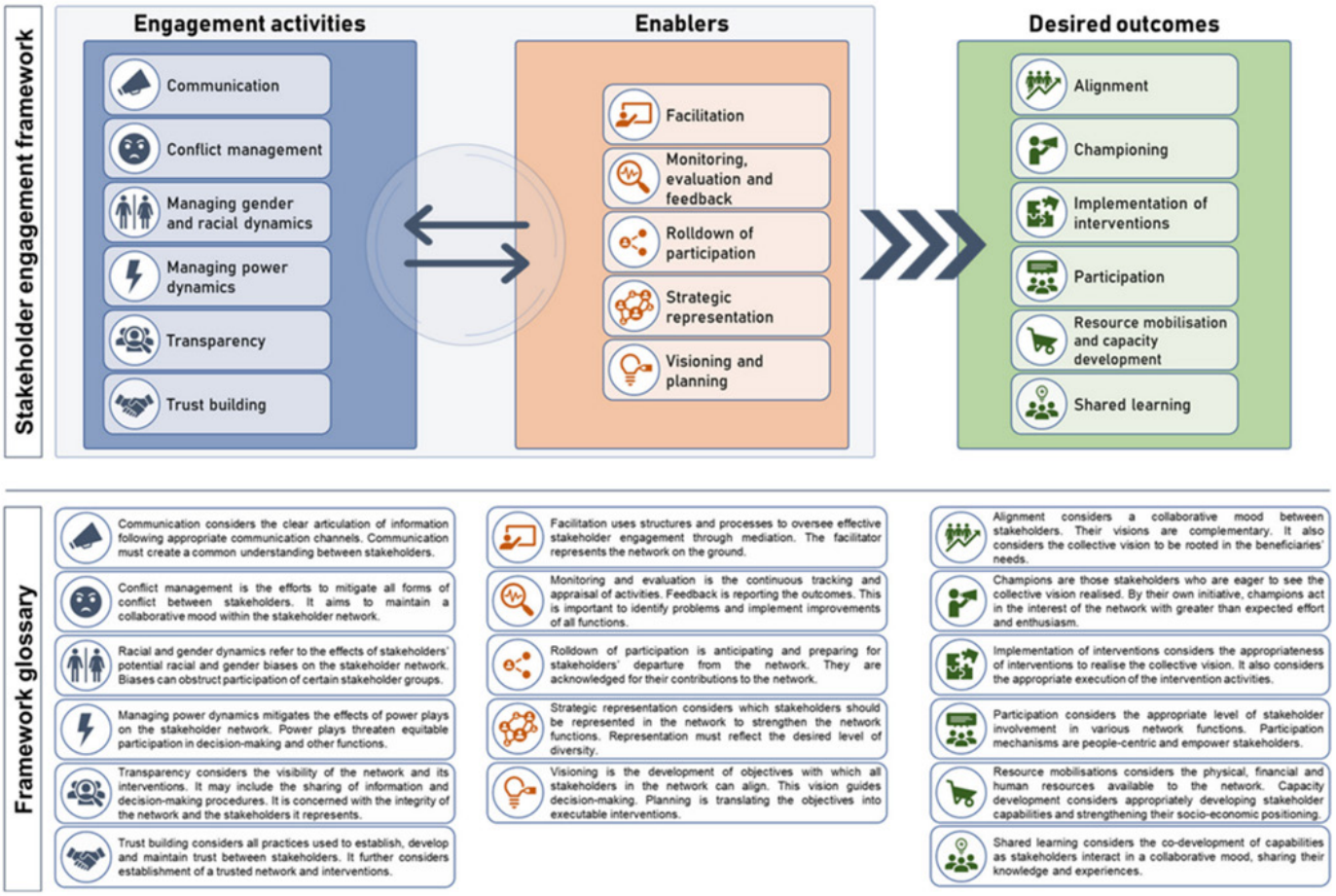
Source: developed by Heikkinen et al. (2007) and Nyström et al. (2014).

Annex 2. Innovation actor roles



Source: developed by Kilelu et al. (2011).

Annex 3. The stakeholder engagement framework



Source: Edlmann and Grobbelaar (2021).

Appendix 2. Key literature on living labs

Akasaka F, Mitake Y, Watanabe K and Shimomura Y. 2022. A framework for 'configuring participation' in living labs. *Design Science* 8:E28. doi: 10.1017/dsj.2022.22
In recent years, 'living lab,' a design approach that actively involves users as partners from the early stage of the design process, has been attracting much attention. Compared with the traditional participatory design or co-design approaches, one of the distinctive features of the living lab approach is that the process of and opportunity for user participation tends to be long-term and complex. Thus, living lab practitioners must appropriately plan and design effective integration of user participation into the design process to promote co-creation with users. In other words, living lab practitioners are required to 'configure user participation' for the effective promotion of co-creation. However, to date, the knowledge on how to properly configure long-term and complex user participation in living labs has not been systematically clarified, nor have its methodologies been developed.

This study develops a novel framework for configuring user participation in living labs. Through a literature review and analysis on living lab case studies, we identified 11 key elements in five categories that should be considered while configuring user participation in living labs. Furthermore, on the basis of the identified elements, we developed a novel framework for configuring user participation in living labs, which is called the participation blueprint. We have demonstrated its use and have also discussed its theoretical and practical contributions to the living lab and co-design research community.

Äyväri A and Jyrämä A. 2017. Rethinking value proposition tools for living labs. *Journal of Service Theory and Practice* 27(5):1024–39. doi: 10.1108/JSTP-09-2015-0205
Purpose: The purpose of this paper is to provide a conceptual analysis on value proposition tools to be used in future empirical research and in building managerial insight. The conceptual analysis focuses on a living lab framework and recent theoretical developments around the concept of value that are reflected in the context of three managerial tools for creating value propositions.

Design/methodology/approach: Using abductive reasoning, the descriptions of the tools were analyzed as cultural texts, as language-in-use in a social context.

Findings: In the context of the living labs approach, the Value Proposition Builder™(VPB) seems to conflict with the ideas and premises of user-centric innovation processes. In the Value Proposition Canvas (VPC), the co-creation aspect is rather vague, as the enterprise and its offerings are presented as creators of value for the customer. Thus, this tool somewhat contradicts the living lab approach. The People Value Canvas (PVC) is aligned with the service-dominant logic and the premises of living labs. However, all three tools largely neglect a deeper acknowledgement of the role of the wider context, the service ecosystem, and the role of networked actors as resource integrators. Moreover, none of the tools explicitly point out the role of enterprises as intermediaries in constructing invitations for value co-creation.

Originality/value: The paper contributes to the Self-Directed Learning (SDL) and living labs literature by conceptual analysis on different value proposition tools: the VPB™, the PVC, and the VPC which are relevant for academics as well as practitioners creating new understanding and insights on the connectedness of the living labs framework and SDL as well as their relationship to managerial tools. By identifying the absent elements of S-D logic from managerial value proposition tools, the paper contributes to current discussions by giving attention from scholars toward investigating managerial tools and by providing a new conceptual analysis for future empirical research. The critical analysis of the managerial tools contributes to managerial practice by emphasizing the need to consciously evaluate the benefits and failures of tools for developing their organizations.

Beaudoin C, Joncoux S, Jasmin JF, Berberi A, McPhee C, Schillo RS and Nguyen VM. 2022. A research agenda for evaluating living labs as an open innovation model for environmental and agricultural sustainability. *Environmental Challenges* 7. doi: 10.1016/j.envc.2022.100505
The magnitude of environmental challenges we are facing today requires the involvement of a diversity of stakeholders and collaborators to develop socially, culturally and economically robust sustainability practices. Living labs catalyze the development of user-centric solutions for complex environmental issues by exploring, co-creating, testing and evaluating innovations within real-world contexts. The living lab approach is relatively new in the environmental and agricultural sectors but is quite well established in many areas such as ICT.

For living labs to play a greater role in environmental sustainability, we present a research agenda related to the evaluation and effectiveness of living labs in the context of environmental and agricultural sustainability. We refer to evaluation as the act of assessing the process and outcomes of a living lab, and effectiveness as the level to which a living lab is successful in achieving a certain desirable process or outcome.

Our research agenda is based on empirical research using an adapted Delphi method—a process to iteratively gather input from a panel of experts—involving a total of 44 researchers and experts in the domains of living labs, evaluation methods and agro-environmental issues. The resulting integrated research agenda identifies important gaps in both research and practice to improve the impact of living labs. Our findings highlight the need to better understand effective use of this collaborative, open innovation approach in research and management focused on environmental and agricultural sustainability. Future research should investigate the knowledge gaps we have identified in terms of diversity of stakeholders, key dimensions of evaluation and how to enable effectiveness of living labs.

Bergvall-Kåreborn B, Eriksson CI, Ståhlbröst A and Svensson J. 2009. A milieu for innovation: Defining living labs. ISPIM Innovation Symposium, Vienna, Austria, December 6–9, 2009.
A new trend of user involvement in open innovation processes has emerged. Concurring with this trend, the living lab concept has been re-vitalized. This concept has attracted attention lately, but there is no coherent view. In this paper, we discuss and define the concept and propose five key components and five key principles for living labs based on experiences from over 30 development and research projects within two living labs: the Botnia Living Lab and Halmstad Living Lab. The key components are (1) ICT and infrastructure, (2) management, (3) partners and users, (4) research and (5) approach. The key principles are, (1) openness, (2) influence, (3) realism, (4) value and (5) sustainability. Our proposed definition of a living lab is a user-centric innovation milieu built on everyday practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values.

Bouwma I, Wigboldus S, Potters J, Selnes T, Van Rooij S and Westerink J. 2022. Sustainability transitions and the contribution of living labs: A framework to assess collective capabilities and contextual performance. *Sustainability* 14(23):15628. dx.doi: 10.3390/su142315628
Living labs are understood as collaborative platforms in which actors from research, government and business, and citizens work together to address complex societal challenges. They are increasingly seen as an instrument to support sustainability transitions, such as transitions to a circular bio-based climate smart society. Living labs can create spaces for joint experimenting and learning by exploring the barriers and possibilities for transition and co-creating appropriate and viable solutions. These high expectations for and increased interest in living labs have sparked a keen interest in methods for assessing the performance of living labs. However, there is not yet an evaluation method or framework that is generally accepted and used. The few existing methods and frameworks mostly focus on the functioning of the living lab itself, and not on its wider impacts.

Building on existing approaches and informed by the experiences in three living labs, we developed an assessment framework that captures the dynamic role and contribution of living labs. This paper describes the framework and how it was developed. The paper contributes to the development of appropriate ways of assessing the functioning of living labs and the ways in which they contribute to sustainability transitions.

Van den Broek J, Van Elzakker I, Maas T and Deuten J. 2020. *Voorbij lokaal enthousiasme – Lessen voor de opschaling van living labs*. Den Haag: Rathenau Instituut.
No abstract, in Dutch.

Bronson K, Devkota R and Nguyen V. 2021. Moving toward generalizability? A scoping review on measuring the impact of living labs. *Sustainability* 13(2):1–16. doi: 10.3390/su13020502
The living labs approach has been applied around the globe to generate innovation within and suited to real-life problems and contexts. Despite the promise of the living lab approach for addressing complex challenges like socioecological change, there is a gap in practitioner and academic community knowledge surrounding how to measure and evaluate both the performance of a given living lab process and its wider impacts. Notably, this gap appears particularly acute in living labs designed to address environmental or agricultural sustainability.

This article seeks to verify and address this knowledge gap by conducting an adopted scoping review method that uses a combination of tools for text mining alongside human text analysis. In total, 138 academic articles were screened, out of which 88 articles were read in full and 41 articles were found relevant for this study. The findings reveal limited studies putting forward generalizable approaches or frameworks for evaluating the impact of living labs and even fewer in the agricultural or sustainability sector. The dominant method for evaluation used in the literature is comparative qualitative case studies. This research uncovers a potential tension regarding living lab work: the specificity of living lab studies works against the development of evaluation indicators and a universal framework to guide the impact assessment of living labs across jurisdictions and studies in order to move toward generalizability.

Burbridge M. 2017. If living labs are the answer—what's the question? A review of the literature. *Procedia Engineering* 180:1725–32. doi: 10.1016/j.proeng.2017.04.335
The world's economy is becoming increasingly knowledge intensive. This will drive further technological, societal and organizational change. A knowledge intensive economy gives the producers of knowledge—universities—a potentially key role in shaping our future. However, this paper shows that neither Australian industry nor universities are good at collaborating for innovation. Change is needed but change is hard, resource intensive and never ending.

This paper demonstrates why change is so difficult and suggests steps for success. It demonstrates why effective leadership is central to the change process and suggests further applied research to understand the practical obstacles that are preventing universities from developing partnerships for innovation. It defines a principle for evidence-based innovation that is fit for the Anthropocene and proposes the Sustainable Development Goals as a measure to understand the impact of university research in order to help move society in the direction society is seeking. It also pries into the Pandora's box of the role of universities in partnering for innovation in the Anthropocene and proposes further research on the role of 'leading by doing' on potential partnerships for innovation.

Burbridge M and Morrison GM. 2021. A systematic literature review of partnership development at the university–industry–government nexus. *Sustainability* 13(24):13780. dx.doi: 10.3390/su132413780
The increasingly entrepreneurial intent of universities implies the commercialization of knowledge and innovation through the triple helix of interactions between universities, industry and government. However, there remains a lack of clarity concerning best practice partnerships for innovation.

This systematic literature review provides insights into the development of partnerships at the university–industry–government nexus and builds on the existing top-down/bottom-up approach for the creation of intermediaries of innovation. The review describes the evolution of these intermediaries, which is driven both by criteria set by partners and the globalization of the knowledge economy. It reveals that the partnership structure most likely to further economic and broader societal goals is the living lab with the inherent focus on open innovation and co-creation. This review reveals that the living lab structure (and including sustainability labs and urban living labs) is the partnership structure utilized for innovation that addresses economic, social and environmental goals.

Two areas are recommended for further research. One concerns the development of a deeper understanding of the relationship between the evolution in the structures of partnerships for innovation and how it is influenced by the globalization of the economy, society and environment, and changing modes of knowledge production. The other is to better understand why the living lab approach to partnership creation is best suited to the delivery of sustainable development objectives and how this learning can be applied to other models of partnership development at the university–industry–government nexus.

Dekker R, Franco Contreras J and Meijer A. 2020. The living lab as a methodology for public administration research: A systematic literature review of its applications in the social sciences. ***International Journal of Public Administration*** **43(14):1207–17. doi: 10.1080/01900692.2019.1668410**
Living labs have become a promising methodology for public administration research to design and study public innovations. Surprisingly, public administration research has paid scant attention to living labs to date. An obvious obstacle to the application of a living lab approach in public administration is unclarities about the value, validity and application of this methodology. This study systematically reviews current applications of living labs in social sciences and links this to opportunities for public administration research. It presents a set of guidelines for the use of living labs in public administration research and reflects upon the value of this specific methodology.

Franz Y. 2015. Designing social living labs in urban research. ***Info*** **17(4):53–66. doi: 10.1108/info-01-2015-0008**
Purpose: The purpose of this paper is to develop a more socially centered understanding of living labs for urban research questions by reflecting on current technologically centered and innovation-driven approaches.

Design/methodology/approach: The paper takes the form of a literature review complemented by conceptual knowledge from practical experiences.

Findings: Urban living labs, as they were introduced from a technological and economic point of view, have to be translated into the context of social sciences. By doing so, they may be a promising tool to stimulate co-creation and collaboration also in urban research projects that focus on social research questions and include diverse target groups. Socially centered living labs take into account the local context by developing a space of encounter for the participants in the urban living lab and by implementing a set of living methods that suit both the research design and the local requirements.

Originality/value: This paper argues that urban living labs can be a valuable tool in urban research to include researchers, politicians, local stakeholders and residents in an open concept of co-creation. It argues that a locally contextualized design in terms of space and methods is necessary to create an environment of trust and collaboration.

Fuglsang L, Hansen AV, Mergel I and Røhnebæk MT. 2021. Living labs for public sector innovation: An integrative literature review. ***Administrative Sciences*** **11(2). doi: 10.3390/admsci11020058**
The public administration literature and adjacent fields have devoted increasing attention to living labs as environments and structures enabling the co-creation of public sector innovation. However, living labs remain a somewhat elusive concept and phenomenon, and there is a lack of understanding of their versatile nature. To gain a deeper understanding of the multiple dimensions of living labs, this article provides a review assessing how the environments, methods and outcomes of living labs are addressed in

the extant research literature. The findings are drawn together in a model synthesizing how living labs link to public sector innovation, followed by an outline of knowledge gaps and future research avenues.

Greve K, Vita RD, Leminen S and Westerlund M. 2021. Living labs: From niche to mainstream innovation management. *Sustainability* 13(2):791. dx.doi: 10.3390/su13020791
Living labs have received increasing attention over the last decade. However, despite their growing popularity and ability to positively impact organizations' innovation performance, mainstream innovation management literature has overlooked the diverse and promising living labs research landscape.

In an effort to move the field forward, this study analyzes extant living labs literature in the domain of innovation management. The study identifies conceptual bases informing living labs research, maps the collaboration between scholars in the field, examines prevailing themes influencing the debate and reveals the influence of living labs research on other domains. Bibliometric methods of co-authorship, keyword co-occurrence analysis as well as bibliographic coupling are employed on two databases. Database A includes 97 focal journal articles and Database B includes all cited sources of Database A, totaling 500 documents.

This study reveals the rapid growth of the scholarly literature on living labs in the innovation management domain, driven by a core group of authors. However, other contributions from highly visible scholars have the potential to connect living lab research to mainstream innovation management studies. The study also identifies the influence of living labs research in different application fields and potential for its further evolution.

Hossain M, Leminen S and Westerlund M. 2019. A systematic review of living lab literature. *Journal of Cleaner Production* 213: 976–88. doi: 10.1016/j.jclepro.2018.12.257
A living lab is a physical or virtual space in which to solve societal challenges, especially for urban areas, by bringing together various stakeholders for collaboration and collective ideation. Although the notion has received increasing attention from scholars, practitioners and policymakers, its essence remains unclear to many.

We therefore performed a systematic literature review of a sample of 114 scholarly articles about living labs to understand the central facets discussed in the nascent literature. In particular, we explored the origin of the living lab concept and its key paradigms and characteristics, including stakeholder roles, contexts, challenges, main outcomes and sustainability. While doing this, we discovered that the number of publications about living labs has increased significantly since 2015, and several journals are very active in publishing articles on the topic.

The living lab is considered a multidisciplinary phenomenon and it encompasses various research domains despite typically being discussed under open and user innovation paradigms. What is more, the existing literature views living labs simultaneously as landscapes, real-life environments, and methodologies, and it suggests that they include heterogeneous stakeholders and apply various business models, methods, tools and approaches.

Finally, living labs face some challenges, such as temporality, governance, efficiency, user recruitment, sustainability, scalability and unpredictable outcomes. In contrast, the benefits include tangible and intangible innovation and a broader diversity of innovation. Based on our analysis, we provide some implications and suggestions for future research.

Keyson DV, Guerra-Santin O and Lockton D. 2016. *Living Labs: Design and Assessment of Sustainable Living*. London: Springer International Publishing. doi: 10.1007/978-3-319-33527-8
This book presents the results of a multiannual project with sustainable living labs in the United Kingdom, Sweden, Germany and the Netherlands. Living labs—as initiated by the authors—have proved to be very promising research, design, co-creation and communication facilities for the development and implementation of sustainable innovations in the home. The book provides an inspiring introduction to both the methodology and business modeling for living lab facilities. Understanding daily living at home is key to designing products and services that support households in their transition to more sustainable

lifestyles. This book not only explores new ways of gaining insights into daily practices, but also discusses developing and testing design methods to create sustainable solutions for households. These new methods and tools are needed because those available are either ineffective or cause rebound effects. Intended for researchers and designers with an interest in the transition to sustainable lifestyles, the book also appeals to company leaders interested in new ways of developing sustainable innovations and offers suggestions for effectively applying living labs for sustainable urban development.

Kim J, Kim YL, Jang H, Cho M, Lee M, Kim J and Lee H. 2020. Living labs for health: An integrative literature review. *European Journal of Public Health* 30(1):55–63. doi: 10.1093/eurpub/ckz105
Background: Living labs are user-focused experimental environments in which users and producers co-create innovative solutions in real-life settings. The aim of this study was to review and synthesize health-related studies that used the living labs approach.

Methods: An integrative literature review of 15 studies was conducted on the application of living lab principles and their usefulness for investing health problems. Three reviewers independently used methodological assessment tools to evaluate the data quality.

Results: Twelve of the 15 studies were published during the past 5 years, while 14 of the 15 studies were conducted in Europe. Older adults were the target population in nine of the 15 studies. The research topics varied, including detecting and monitoring daily life, fall prevention and social support. All the studies applied multimethod approaches and a real-life setting. Use of the living lab approach appeared to improve the quality of life, physical and social health and cognitive function of the target populations.

Conclusions: The results showed that the living lab approach was more commonly used to investigate health problems in older adult populations. The living lab appears to be an appropriate method for developing innovative solutions to improve the health of vulnerable groups.

Knight-Davidson P, Lane P and McVicar A. 2020. Methods for co-creating with older adults in living laboratories: A scoping review. *Health and Technology* 10(5):997–1009. doi: 10.1007/s12553-020-00441-6
The purpose of this literature review is to enhance understanding of methods and processes used in living labs that are concerned with the co-creation of technological and service innovations with older adults. It is relevant to the growing discourse about how to enable the uptake and use of goods and services designed to promote older adults' independence and how to amplify the potential for economic growth that the demand for such goods and services offers.

In this paper, the methods for co-creating with older adults in living labs are explored through a scoping review of the literature. The review utilises a set of tools advanced by Arksey and O'Malley's (2005) framework, to collect, evaluate and present the available literature and provide a rigorous and transparent analysis to allow other researchers to replicate the study if they so wish. The findings suggest that a broad range of methods (some of which follow user-centered design and participatory research approaches) are used in living laboratories with older people from being observed interacting with products to them having full involvement in design processes and activities. These might be carried out over short, mid or long durations and in a variety of temporary or permanent settings (e.g. personal homes, mock-up homes, community centers). The analysis also points to greater value being placed on those methods that have high and active user involvement in co-creation, in comparison to methods that have lower engagement with users in the process.

However, reflecting on the literature, the authors of this paper suggest that when co-creating with older adults, a level of creative thinking might be necessary, particularly in situations where user needs cannot be readily articulated, and this may indicate the need for using less active user involvement methods. This review of the literature suggests that inclusive, user-centered approaches are most conducive with "needs finding" and effective "co-creation" with older adults. Moreover, individual living labs can benefit from adopting a repertoire of methods, borrow from other disciplines and adapt a flexibility of approach for effective co-creation with older adults.

Lapointe D and Guimont D. 2015. Open innovation practices adopted by private stakeholders: Perspectives for living labs. *Info* 17(4):67–80. doi: 10.1108/info-01-2015-0003

Purpose: This paper aims to explore the role of private stakeholders in the living lab ecosystem and the relationship of private stakeholders to open innovation practices. There is extensive literature on private stakeholders and open innovation, but seldom mention is made on the specific question of how private stakeholders integrate open innovation in the context of a living lab.

Design/methodology/approach: The authors will analyze qualitatively how private businesses that have participated in an in situ open innovation evaluate and perceive their open innovation practices. Therefore, how they relate to open innovation. Then, the authors will identify a typology of the businesses in relation to open innovation.

Findings: The research focused on the relationship of private stakeholders to open innovation in the context of in situ open innovation activities. The results obtained are consistent with literature on open innovation (Chesbrough 2003). However, there are differences: If the elements mentioned by the respondents are described in literature, their representation of open innovation and its components allows us to affirm that this practice is not generalized and that it is often open to interpretation. That emphasizes the importance of the role living labs can play as intermediaries to accompany private stakeholders in the open innovation process. Private stakeholders look for a guide to develop their open innovation knowhow and find their way in the open innovation ecosystem.

Originality/value: The value of this paper is to bridge the research on open innovation done with private organizations and the research on living labs. The research literature did not pay much attention to the representation of the private stakeholders in the open innovation ecosystem. This paper has provided the start to open up that field.

Leminen S, Defillippi R and Westerlund M. 2015. Paradoxical tensions in living labs. The XXVI ISPIM Conference: Shaping the Frontiers of Innovation Management, Budapest, Hungary, June 14-17, 2015. https://www.researchgate.net/publication/278899570

This paper examines the tensions and paradoxes related to open innovation taking place in living labs. Although the open innovation model is spreading rapidly and living labs are an increasingly popular way to accelerate innovation processes, they are under-researched. There is a substantial need for more research on innovation mechanisms in living labs. This study focuses on three main classes of tensions that characterize open innovation in living labs: (1) management, (2) users and (3) the way of working. The suggested categorization of tensions into paradoxes is based on a theory review and an empirical analysis of 26 living labs in four countries. This paper proposes that living labs foster emergence of paradoxical tensions and act as a mechanism to reorganize paradoxical tensions. The paper concludes with theoretical and managerial implications and suggests directions for future research.

Leminen S and Westerlund M. 2019. Living labs: From scattered initiatives to a global movement. *Creativity and Innovation Management* 28(2):250–64. doi: 10.1111/caim.12310

This study explores the emergence of the living labs movement based on a literature review and interviews with experts acquainted with early living labs. The study contributes to the growing literature on innovation through living labs by addressing a research gap on why and how this movement is evolving. So doing, the study discusses the emergence of living labs from the perspectives of (i) early living lab pioneers, (ii) early living lab activities in Europe, especially at Nokia Corporation, (iii) European Union (EU) funding that supported the creation of living labs, (iv) national living lab networks and (v) the multinational ENoLL. Moreover, upon highlighting major events in the emergence of living labs, the study identifies three consecutive phases of the global living lab movement: (1) toward a new paradigm, (2) learning from experience and (3) professional living labs.

Lupp G, Zingraff-Hamed A, Huang JJ, Oen A and Pauleit S. 2021. Living labs: A concept for co-designing nature-base solutions. *Sustainability* 13(1):1–22. doi: 10.3390/su13010188
Living labs are recognized as a progressive form to foster innovation and the strengthening of collaborative planning. The concept has received strong attention by the EU's research and innovation agendas recently. This contribution investigates how a living lab approach could be used for the design and implementation of nature-based solutions (NBS). NBS are gaining acceptance as a more sustainable solution for reducing the exposure to natural hazards and vulnerability to events, such as increased flooding in changing climate. However, a lack of collaborative approaches hinders their broader implementation.

A literature review on the theoretical aspects of the living labs concept in the context of NBS is conducted, and we compare the theoretical findings with practices that were observed by two case studies implementing NBS in a collaborative manner: the Isar-Plan River Restoration in Munich, Germany, and the Mountain Forest Initiative (Bergwaldoffensive). Both of the case studies had already started well before the concept of living labs gained wider popularity. Both award-winning cases are recognized good practices for their exemplary in-depth stakeholder involvement. The paper discusses the concepts and approaches of living labs and reflects on how they can serve and support in-depth participatory stakeholder involvement.

Maas T, Van den Broek J and Deuten J. 2017. Living labs in Nederland: Van open testfaciliteit tot levend lab. Den Haag: Rathenau Instituut.
No abstract, in Dutch.

Malmberg K and Vaittinen I, eds. 2017. *Living Lab Methodology Handbook*. Europe: European Network of Living Labs, U4IoT Consortium. doi: 10.5281/zenodo.1146321
Top experts in living lab research and practice from ENoLL have contributed to the *Living Lab Methodology Handbook* by sharing their knowledge on the most recent findings on the topic. This handbook introduces research background and serves as a practical guide for researchers and practitioners on living lab methodologies, co-creation and user engagement. It also aims to inspire the reader with the lessons learned from thorough research together with practical experiences from real-life cases. The handbook specifically focuses on the topical area of the Internet of Things (IoT), and explains how the living lab approach can greatly support the research and development activities in that area.

This handbook was initiated under the coordination and support action User Engagement for Large Scale Pilots in the Internet of Things (U4IoT) that provides online and offline toolkits, workshops and other forms of support to actively engage end-users and citizens in the pilot projects of the European IoT Large-Scale Pilots Programme. This project has received funding from the EU's Horizon 2020 research and innovation program and the Swiss State Secretariat for Education, Research and Innovation under grant agreement No 732078.

Mamba MSN and Isabirye N. 2015. A framework to guide development through ICTs in rural areas in South Africa. *Information Technology for Development* 21(1):135–50. doi: 10.1080/02681102.2013.874321
The purpose of this paper is to produce a framework to help guide the contribution of ICTs to the development of rural areas. Researchers argue that information and communication technology for development (ICT4D) projects have a high failure rate and seldom meet their expectations. However, research also shows that billions worth of funds have been spent on ICT4D projects in developing countries. Studies suggest that the reason for failure is largely because of the lack of frameworks to guide development through ICT in developing countries. This study presents the findings of a case study research project evaluating two rural ICT cases to determine how the success rate of ICT4D projects can be improved. The researcher interviewed individuals who have participated in ICT4D projects in Alice and Dwesa; both projects were based in rural areas in Eastern Cape Province of South Africa. The output of this study is a framework that can help guide the contribution of ICTs to development.

Marvin S, Bulkeley H, Mai L, McCormick K and Palgan YV, eds. 2018. *Urban Living Labs: Experimenting with City Futures*. London: Routledge.
All cities face a pressing challenge—how can they provide economic prosperity and social cohesion while achieving environmental sustainability? In response, new collaborations are emerging in the form of urban living labs—sites devised to design, test and learn from social and technical innovation in real time. The aim of this volume is to examine, inform and advance the governance of sustainability transitions through urban living labs. Notably, urban living labs are proliferating rapidly across the globe as a means through which public and private actors are testing innovations in buildings, transportation and energy systems.

Yet despite the experimentation taking place on the ground, we lack systematic learning and international comparison across urban and national contexts about their impacts and effectiveness. We have limited knowledge on how good practice can be scaled up to achieve the transformative change required. This book brings together leading international researchers within a systematic comparative framework for evaluating the design, practices and processes of urban living labs to enable the comparative analysis of their potential and limits. It provides new insights into the governance of urban sustainability and how to improve the design and implementation of urban living labs in order to realize their potential.

Mastelic J, Sahakian M and Bonazzi R. 2015. How to keep a living lab alive? *Info* 17(4):12–25. doi: 10.1108/info-01-2015-0012
Purpose: This paper aims to explore how living labs might be evaluated, building on the current efforts of ENoLL to encourage new members, and complementing their existing criteria with elements from business model development strategies—specifically the Business Model Canvas (BMC) (Osterwalder and Pigneur 2010).

Design/methodology/approach: First, it is explored how living labs have emerged, at the intersection of transition management, open innovation and collaborative consumption. It is then suggested that the BMC could be a complementary tool in living lab evaluation.

Findings: This tool helped identify three important elements missing from current ENoLL evaluation criteria: (1) identification of the cost structure, (2) customer segments and (3) the revenue stream. The case study of an energy living lab created in Western Switzerland is used to reflect on the strengths and weaknesses of different evaluation criteria; this paper is then concluded with some ideas on how future research might contribute to further strengthening living lab evaluation process towards long-term "sustainability."

Originality/value: This article will be of value for ENoLL to refine its evaluation criteria for the next "wave" of application. It could as well help living labs to reflect on how to keep a living lab alive.

Mbatha SP and Musango JK. 2022. A systematic review on the application of the living lab concept and role of stakeholders in the energy sector. *Sustainability* 14(21):14009. doi: 10.3390/su142114009
The living lab concept is identified as having the potential to provide a platform to test technologies and support energy transition. However, the application of the concept to the energy sector is limited, though emerging. This study undertook a systematic literature review to understand the extent of the application of the living lab concept, with the particular aim of informing the processes to establish such a platform in urban Africa. Using a sample of 35 papers, only 17 papers were related to energy living labs, while 18 papers were outside the energy field. The scale and contexts of the application of living labs were diverse. However, not all initiatives that defined themselves as living labs were characterized by elements typical of the concept of a living lab. Further, how the stakeholders were identified, and the stakeholder recruitment process in energy living labs, was unclear in the sampled studies. A recommendation is to improve transparency in the stakeholder identification, engagement and recruitment process in energy living labs and to incorporate gendered issues into the setup and management of urban energy living labs.

Nguyen HT and Marques P. 2022. The promise of living labs to the Quadruple Helix stakeholders: Exploring the sources of (dis)satisfaction. *European Planning Studies* 30(6):1124–43. doi: 10.1080/09654313.2021.1968798

Despite the normative view that Quadruple Helix collaborations (with government, academia, industry and civil society) such as living labs are prescribed to enhance regional innovation performance, there is scarce knowledge of the sustainability of such collaborations from the perspective of the stakeholders who are supposed to engage in such initiatives. To address this gap, the purpose of this paper is to empirically explore the implementation of the Quadruple Helix for innovation from a stakeholder perspective, by understanding the expectations as well as the perceived benefits and challenges of the collaboration. Through a qualitative research design, this paper presents an in-depth case study of a living lab in the region of Catalonia. Our results challenge the normative view of Quadruple Helix approaches and of living labs; we also offer suggestions to manage future collaborations and to inform further evidence-based policy. On the whole, partnership leadership and coordination are critical to bridge the expectation-implementation gap toward stakeholder satisfaction and collaboration sustainability.

Nyström AG, Leminen S, Westerlund M and Kortelainen M. 2014. Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management* 43(3): 483–95. doi: 10.1016/j.indmarman.2013.12.016

Innovation networks are embodied and shaped by their participants. This paper examines actors' roles in living labs, which are defined as networks of open innovation. The study utilizes four approaches to roles: (1) structuralist, (2) symbolic interactionist, (3) resource-based and (4) action-based approaches. Our empirical analysis of 26 living labs in four different countries identifies a number of actor roles associated with open innovation. In addition, it reveals four role patterns characteristic of living labs: (1) ambidexterity, (2) reciprocity, (3) temporality and (4) multiplicity. These patterns distinguish actor collaboration in networks characterized by heterogeneous actors, the coexistence of individual and shared motives, high degree of openness and user involvement. Scholars and practitioners of innovation learn that understanding of role patterns in living labs can contribute to building, utilization and orchestration of open innovation networks.

Ondiek MA and Moturi C. 2019. An assessment of the sustainability of living labs in Kenya. *Innovation & Management Review* 16(4):391–403. doi: 10.1108/INMR-08-2018-0058

Purpose: There has been a high rate of failure among the living labs in Kenya resulting in the expected outcomes not being fully realized. This paper aims to assess the sustainability of living labs in Kenya.

Design/methodology/approach: Based on the four capital method of sustainable development evaluation framework, data was collected through interviews and questionnaires from innovators, users and employees among the 25 living labs in Kenya.

Findings: The research found that (i) some innovators are not familiar with the living labs, (ii) the living labs are innovative and prepared to survive in future, (iii) some labs have strategic plans on how to pursue future environment and have developed ways of choosing the right people to incubate, (iv) there is an inability to get enough funding from the host organizations and (v) there is limited knowledge on the supervision level of the operations. A model is proposed that can be generalized to other living labs in developing countries.

Research limitations/implications: The study was done in Nairobi, where most of the living labs are situated.

Practical implications: The study concludes by emphasizing the user involvement during innovation process. There is a need to expand the capacities of living labs to accommodate more people to ensure more innovations are supported at a time. The senior managers in charge of the living labs should increase the level of supervision to ensure that the labs are effective in their incubation efforts and institutionalize support of the host organization to the labs to ensure continued growth and expansion.

Originality/value: The findings of this study are of value to the research community, the decision-makers and policymakers as it seeks to document the current status of the living labs in the Kenya.

Paskaleva DK and Cooper DI. 2021. Are living labs effective? Exploring the evidence. *Technovation* 106. doi: 10.1016/j.technovation.2021.102311
The main question addressed in this article is whether the evidence that is publicly available validates the claim that living labs are an effective means for promoting innovation. Owing to widespread promotion of their usefulness as a practical tool for pursuing innovation, living labs have enjoyed increasing attention from researchers, policymakers and practitioners. But despite the booming interest in living labs—where innovation is generally perceived as taking place in real-life environments—their actual performance remains under-researched. It has yet to be demonstrated whether, in practice, living labs speed up the design of "solutions" to societal challenges or the sharing of user value.

This study aims to assess the existing evidence about whether they really deliver. A broadly based literature review was conducted to discover whether those initiating living labs report success—achieving the objectives/benefits they set themselves. Conclusions are drawn about whether the evidence is, at present, strong enough to warrant the promotion this approach receives. We suggest that, despite their 20-year history, the operationalization of and outcomes from living labs are still poorly understood owing to a paucity of published evidence, compounded by inadequate research design and insufficient attention to implementing and reporting performance evaluations.

Schäpke N, Bergmann M, Stelzer F and Lang DJ. 2018. Labs in the real world: Advancing transdisciplinary research and sustainability transformation: Mapping the field and emerging lines of inquiry. *GAIA - Ecological Perspectives for Science and Society* 27(1):8–11. doi: 10.14512/gaia.27.S1.4
There is a strong trend toward research in society-based laboratories, especially in relation to sustainability. Semantic analysis reveals related discourses and emerging lines of inquiry, namely transformative potential, transdisciplinarity and learning. Real-world laboratories are a dynamic example of this research. Contributions of how to deepen and broaden their analysis are presented.

Steen K and Van Bueren E. 2017. The defining characteristics of urban living labs. *Technology Innovation Management Review* 7(7). www.timreview.ca
The organization of supported and sustainable urban interventions is challenging, with multiple actors involved, fragmented decision-making powers, and multiple values at stake. Globally, urban living labs have become a fashionable phenomenon to tackle this challenge, fostering the development and implementation of innovation, experimentation and knowledge in urban, real-life settings while emphasizing the important role of participation and co-creation.

However, although urban living labs could in this way help cities to speed up the sustainable transition, urban living lab experts agree that, in order to truly succeed in these ambitious tasks, the way urban living labs are being shaped and steered needs further research. Yet, they also confirm the existing variation and opaqueness in the definition of the concept.

This article contributes to conceptual clarity by developing an operationalized definition of urban living labs, which has been used to assess 90 sustainable urban innovation projects in the city of Amsterdam. The assessment shows that the majority of the projects that are labeled as living labs do not include one or more of the defining elements of a living lab. In particular, the defining co-creation and development activities were found to be absent in many of the projects. This article makes it possible to categorize alleged living lab projects and distill the "true" living labs from the many improperly labeled or unlabeled living labs, allowing more specific analyses and, ultimately, better targeted methodological recommendations for urban living labs.

Tercanli H and Jongbloed B. 2022. A systematic review of the literature on living labs in higher education institutions: Potentials and constraints. *Sustainability* 14(19):12234. dx.doi: 10.3390/su141912234

Living labs have emerged as an interface for higher education institutions to collaborate with companies, citizens, nonprofit and government organizations to address a variety of problems around social challenges and sustainable development. In this systematic literature review, we summarize the existing knowledge on how universities shape and manage the living labs they are associated with and how they align with their core missions of education and research and—in particular—their social missions.

Following PRISMA guidelines for a systematic literature review, we analyzed journal articles, conference papers and book chapters published between 2008 and 2020, capturing 93 university-governed living lab experiences from across the world. Our findings show that Living labs are developing from bottom-up initiatives, often at the fringe of higher education institutions, toward more self-standing entities implementing strategies to undertake social outreach activities. living labs require their host universities to intensify the relationships with their stakeholders and work on capacity building and focus on interdisciplinary and transdisciplinary research methodologies. Finally, our literature review points to the need for further research on the hybrid governance approaches displayed by living labs, particularly looking at the roles and responsibilities of academics involved in managing living lab initiatives.

Thees H, Pechlaner H, Olbrich N and Schuhbert A. 2020. The living lab as a tool to promote residents' participation in destination governance. *Sustainability* 12(3):1120. dx.doi: 10.3390/su12031120

Growing numbers of tourist arrivals, in combination with community-centered tourism products, have fueled the recent debate over tourism and a redefining of local steering processes. This has also called for the participation of residents in governance processes. One tool to utilize residents' participation and cross-stakeholder involvement is the living lab, which also functions as a medium for self-organization.

This article tackles the research gap that exists in the combination of the living lab mechanisms and destination governance. Therefore, the research questions address the characteristics and mechanisms of living labs and the potential for residents' participation. These efforts are operationalized through a systematic literature review on living labs, which involves 40 articles. The transfer of the living lab characteristics toward destination governance reveals that certain drivers and barriers exist when implementing the living labs in the governance process, such as the combination of destination and city planning or the redefining of hierarchical structures. The systematic literature review recommendations for future research are based on the interface of living labs and destination governance.

Van Geenhuizen M. 2018. A framework for the evaluation of living labs as boundary spanners in innovation. *Environment and Planning C: Politics and Space* 36(7):1280–98. doi: 10.1177/2399654417753623

Living labs, as a methodology to enhance user-centric innovation, have large potentials in bringing inventions to the marketplace, but their performance can benefit more from evaluation. This article develops a novel framework for evaluation of living labs, including (i) a system approach providing an analytical view on living labs' performance and results, (ii) a focus on actor-complexity and boundary-spanning needs, (iii) a set of questions concerning, e.g., absorption of user-feedback, satisfaction among actors, and openness and connecting with larger networks, (iv) a list of key performance factors and (v) a focus on participatory evaluation. The design of this evaluation framework rests on a comprehensive literature search and case studies representing different actor complexity, namely home-solutions in healthcare, reconstruction of large (multi)functional buildings, and multiple combinations of activity (university campuses). Key performance factors are found to be (1) an early involvement of adequately skilled users in multiple learning processes, including absorption of feedback, and (2) a broader but balanced set of actors connecting with upscaling and acceptance in the market. Also, boundaries need to be better bridged by learning how to handle conflicts and deal with intermediation, while respecting shared goals and interests. Specifically, university living labs call for maintaining a solid relation with cities

and their actors. Overall, an explicitly designed evaluation framework is a key part of the working plan of living labs. The results also indicate a need for stronger attention for boundary-spanning in evaluation, because living labs are increasingly applied in comprehensive multiactivity settings.

Veeckman C, Schuurman D, Leminen S and Westerlund M. 2013. Linking living lab characteristics and their outcomes: Towards a conceptual framework. *Technology Innovation Management Review* December:6–15
Despite almost a decade of living lab activity all over Europe, there still is a lack of empirical research into the practical implementation and the related outcomes of living labs. Therefore, this article proposes a framework to create a better understanding of the characteristics and outcomes of living labs. We investigate three living labs in Belgium and one in Finland to learn how the different building blocks of living lab environments contribute to the outputs of innovation projects launched within the lab. The findings imply that managers and researchers contemplating innovation in living labs need to consider the in-tended inputs and outcomes, and reframe their innovation activities accordingly. We formulate practical guidelines on how living labs should be managed on the levels of community interaction, stakeholder engagement and methodological setup to succeed in implementing living lab projects and to create user-centered innovations. That way, living lab practitioners can work toward a more sustainable way of setting up living labs that can run innovation projects over a longer period of time.

Witteveen L, Eweg R, Smits T and Voskamp-Harkema W. 2016. Design principles for living labs aiming at sustainable development: The role of higher education in living labs. Competence 2016 Wageningen. Wageningen, the Netherlands, October 19-21, 2016. https://www.researchgate.net/publication/311456793
With the global agreement on the Sustainable Development Goals (SDGs) and the recent Paris climate agreement, it is time to act and advance a sustainable future. The SDGs express an international shared accountability for major global issues such as poverty, climate change and conflicts over resources and cultures. Also, Higher Education (HE) institutes will be judged on the impact of their education and research on sustainable development. This accountability of HE institutes is increasingly referred to as a new function of universities besides educations and research. Considering living labs as *major learning configurations* to reach social-ecological sustainability a transdisciplinary, multi-stakeholder approach requires collaboration and learning between science, governance, business and users.

The consequential search for higher education is to explore how such 'quadruple helix' learning and innovation processes are facilitated. The paper explores a real-life environment where knowledge institutions collaborate with policymakers, entrepreneurs and the public while combining conventional education and empirical research with innovative learning configurations and action-research. The paper concludes on four design principles for living labs from a HE perspective: *fostering inclusive quadruple helix participation, creating authentic learning environments that focus on a sustainable future, stimulating reflexivity in learning and innovation for sustainability and facilitating interaction, knowledge sharing and open system management.*

Witteveen L, Fliervoet J, Roosmini D, Van Eijk P and Lairing N. 2023. Reflecting on four living labs in the Netherlands and Indonesia: A perspective on performance, public engagement and participation. *Journal of Science Communication* 22(3):A01 doi: 10.22323/2.22030201
Living labs need to improve their performance to address urgent social and environmental sustainability challenges. A framework combining the dimensions of environment and focus, methods and collaborative action, and outcomes with a life cycle perspective allowed analyzing of four living labs in the Netherlands and Indonesia. These living labs present differences in environment but are similar for the focus on sustainability transition processes. The reflection reveals the importance of considering public engagement and participation needed to foster a responsible approach and a sustainable performance of living labs.

Zipfel N, Horreh B, Hulshof CTJ, de Boer AGEM and Van der Burg-Vermeulen SJ. 2022. The relationship between the living lab approach and successful implementation of healthcare innovations: An integrative review. *BMJ Open* 12(6):e058630. doi: 10.1136/bmjopen-2021-058630

Objectives: The concept of living labs as a research method to enhance participation of end-users in the development and implementation process of an innovation gained increasing attention over the past decade. A living lab can be characterized by five key components: (1) user-centric, (2) co-creation, (3) real-life context, (4) test innovation and (5) open innovation. The purpose of this integrative literature review was to summarize the literature on the relationship between the living lab approach and successful implementation of healthcare innovations.

Methods: An integrative literature review searched PubMed, EMBASE, PsycINFO and Cinahl databases for articles published between January 2000 and December 2019. Studies were included when a living lab approach was used to implement innovations in healthcare and implementation outcomes were reported. Included studies evaluated at least one of the following implementation outcomes: acceptability, adoption, appropriateness, feasibility, fidelity, implementation cost, penetration or sustainability. Quality was assessed based on a tool developed by Hawker et al. (2002).

Results: Of the 1173 retrieved articles, 30 studies were included of which 11 were of high quality. Most studies involved a combination of patients/public (N=23) and providers (N=17) as key stakeholders in the living lab approach. Living lab components were mostly applied in the development phase of innovations (N=21). The majority of studies reported on achievement of acceptability (N=22) and feasibility (N=17) in terms of implementation outcomes. A broader spectrum of implementation outcomes was only evaluated in one study.

We found that in particular six success factors were mentioned for the added-value of using living lab components for healthcare innovations: (1) leadership, (2) involvement, (3) timing, (4) openness, (5) organizational support and (6) ownership.

Conclusions: The living lab approach showed to contribute to successful implementation outcomes. This integrative review suggests that using a living lab approach fosters collaboration and participation in the development and implementation of new healthcare innovations.

Appendix 3. Key literature on innovation platforms

Adekunle AA, Fatunbi AO and Jones MP. 2010. How to set up an innovation platform: A concept guide for the Sub-Saharan African challenge programme (SSA CP). Accra, Ghana: Forum for Agricultural Research in Africa (FARA).
No abstract.

Adekunle AA and Fatunbi AO. 2012. Approaches for setting-up multi-stakeholder platforms for agricultural research and development. *World Applied Sciences Journal* 16(7):981–88.
In order to facilitate improved returns to research and development in African agriculture, the innovation systems approach, which engenders the involvement of multiple stakeholders in its innovation pathway, has been proposed. Despite the potential of this approach, the understanding of its implementation and particularly of the process of setting up its multistakeholder platform is still largely lacking. Yet, this platform is critical to the success and sustainability of the operations of the platform.

This article introduces the concept of integrated agricultural research for development (IAR4D) and the constituent innovation platform as a workable multistakeholders approach for sustainable agricultural research and development. The IAR4D approach entails a multisectoral orientation to agricultural problem diagnosis and draws on integrated approaches using "hard" and "soft" sciences to provide solutions, while maximizing available resources. IAR4D is premised on the innovation systems approach and requires systemic interaction among all stakeholders around specific commodities or production systems. The procedure for the establishment of an innovation platform requires a value chain analysis of the commodity of interest, followed by a systematic engagement of the identified stakeholders to the platform. The stakeholders in a balanced innovation platform will cut across the private and the public sectors with distinct engagement of the nontraditional stakeholders as input dealers, financial institutions, policymakers, etc. The activity of a typical innovation platform could be kickstarted by joint development of a business plan and its proactive implementation in a partnership mood. A functional innovation platform will normally experience a series of iterative learning at the interphase of which innovation is generated. The setup of a multistakeholder platform in the IAR4D mode has potential to function effectively as a model for regional and national agricultural research for development planning.

Boogaard B, Klerkx L, Schut M, Leeuwis C, Duncan A and Cullen B. 2013. Critical issues for reflection when designing and implementing research for development in innovation platforms. Report for the CGIAR Research Program on Integrated Systems for the Humidtropics. Ibadan, Nigeria: CGIAR; Wageningen, the Netherlands: Knowledge, Technology & Innovation Group (KTI), Wageningen University and Research Centre.
This study aims to increase awareness about the complexity of research in innovation platforms, including (new) roles of research(ers). The main target group of this document is therefore researchers and project managers in Humidtropics, but the document may be of interest to research for development practitioners and other decision-makers as well. We focused less on the practicalities of innovation platforms, because quite a few hands-on manuals have been written on innovation platforms (e.g. Adekunle et al. 2010; Nederlof et al. 2011; Makini et al. 2013; Pali and Swaans 2013). Instead we focused on the reflective level by addressing relevant reflective issues and questions. As such this document is an invitation for continuous (self-)reflection on what we are doing, where we are going and why.

This document builds on the Humidtropics Practice Briefs on innovation platforms. The document can be helpful to (i) reflect upon the credibility, legitimacy and relevance of research in innovation platforms, (ii) continuously discuss and (re)define roles and responsibilities in innovation platforms, (iii) support decision-making while operationalizing innovation platforms, (iv) reflect on the operationalization of innovation platforms, and (v) enhance joint learning experiences from innovation platforms.

Brouwer H, Woodhill J, Hemmati M, Verhoosel K and Van Vugt S. 2015. The MSP guide: How to design and facilitate multi-stakeholder partnerships. Wageningen, the Netherlands: Wageningen Centre for Development & Innovation (WCDI).
No abstract.

Cadilhon J. 2013. A conceptual framework to evaluate the impact of innovation platforms on agrifood value chains development. 138th EAAE Seminar on Pro-poor Innovations in Food Supply Chains, Ghent, Belgium, September 11-13, 2013.
Innovation platforms are equitable, dynamic spaces designed to bring heterogeneous actors together to exchange knowledge and take action to solve a common problem. Although innovation platforms are being set up to attain collectively defined development objectives, there are limited methods and tools available using quantitative data to evaluate whether they are effective.

This paper elaborates a conceptual framework based on elements from new institutional economics and marketing relationship management to model the impact pathways within innovation platforms and how they contribute to attaining the objectives of the rural communities involved. The paper also proposes a field research protocol based on focus group discussions, semi-directive interviews of key stakeholders associated with the innovation platforms and individual surveys of platform members. The data collected is both qualitative and quantitative in nature allowing useful triangulation to test the model. Successive empirical tests of the model in different contexts should allow long-term strengthening and field validation of the conceptual framework.

Cárdenas LFS, Álvarez LVB, González YLV, Díaz-Piraquive FN and Silva HFC. 2021. Public innovation through co-creation platforms in response to the Covid-19 pandemic. *In* Uden L, Ting I-H and Wang K, eds. *Knowledge Management in Organizations*. Cham, Switzerland: Springer International Publishing. 111–22. doi: 10.1007/978-3-030-81635-3
The participation of citizens to solve public challenges is a driver to implement public innovation. Addressing new mechanisms and arenas that facilitate citizen participation is one of the challenges on government agendas, especially under changing, complex and social distancing scenarios such as those caused by the Covid-19 pandemic. Therefore, digital platforms that promote co-creation between citizens, governments and other actors in countries' innovation ecosystems are becoming more and more necessary, but at the same time, there is a need to study their scope and contributions to generate transparent, equitable, inclusive and people-centered citizen participation processes. Indeed, the research aim was to make a trend analysis on the field integrating two methods: (1) a literature review about two concepts related to public innovation platforms (co-creation and citizen participation) and (2) a web content analysis on three platforms that generated co-creation exercises to solve challenges in the Covid-19 pandemic. The main results show the need to study the challenges and contributions of digital platforms to make public innovation the result of a collaborative effort that goes beyond the ideation stages to implement solutions and generate public value.

Carroll GP, Srivastava S, Volini AS, Piñeiro-Núñez MM and Vetman T. 2017. Measuring the effectiveness and impact of an open innovation platform. *Drug Discovery Today* 22(5):776–85. doi: 10.1016/j.drudis.2017.01.009
Today, most pharmaceutical companies complement their traditional research and development (R&D) models with some variation on the open innovation approach in an effort to better access global scientific talent, ideas and hypotheses. Traditional performance indicators that measure economic returns from R&D through commercialization are often not applicable to the practical assessment of these open innovation approaches, particularly within the context of early drug discovery. This leaves open innovation programs focused on early R&D without a standard assessment framework from which to evaluate overall performance. This paper proposes a practical dashboard for such assessment, encompassing quantitative and qualitative elements, to enable decision-making and improvement of future performance. The use of this dashboard is illustrated using real-time data from the Lilly Open Innovation Drug Discovery program.

Cullen B, Tucker J, Snyder K, Lema Z and Duncan A. 2014. An analysis of power dynamics within innovation platforms for natural resource management. *Innovation and Development* 4(2):259–75. doi: 10.1080/2157930X.2014.921274
Innovation systems thinking is increasingly influencing approaches to sustainable agricultural development in developing world contexts. This represents a shift away from technology transfer toward recognition that agricultural change entails complex interactions among multiple actors and a range of technical, social and institutional factors. One option for practically applying innovation systems thinking involves the establishment of innovation platforms. Such platforms are designed to bring together a variety of different stakeholders to exchange knowledge and resources and take action to solve common problems. Yet relatively little is known about how innovation platforms operate in practice, particularly how power dynamics influence platform processes.

This paper focuses on a research-for-development project in the Ethiopian highlands which established three innovation platforms for improved natural resource management. The "power cube" is used to retrospectively analyze the spaces, forms and levels of power within these platforms and the impact on platform processes and resulting interventions. The overall aim is to highlight the importance of power issues in order to better assess the strengths and limitations of innovation platforms as a model for inclusive innovation. Findings suggest that while innovation platforms may achieve some short-term success in creating spaces for wider participation in decision-making processes, they may be significantly influenced by forms of power which may not always be visible or easily challenged.

Dondofema R and Grobbelaar SS. 2020. Supporting innovation through a multi-level platforms approach: A case study of the South African fresh fruit industry. *African Journal of Science, Technology, Innovation and Development* 12(4):421–34. doi: 10.1080/20421338.2019.1681102
Agricultural innovation platforms have become recognized as a key mechanism through which to stimulate innovation for inclusive development by serving as a space for agricultural stakeholders to engage, and to develop and diffuse agricultural innovations. This study investigates how an agricultural innovation environment is created through a multilevel platform. Through grounded theory methodology this article presents a conceptual management framework on the activities to establish and manage the functioning of agricultural multilevel innovation platforms based on the results of a systematic literature review. We then evaluate the credibility and conformability of the framework though analyzing the Fruit SA multilevel platform as a case study. The utility of this analysis for future work is to develop a more complete understanding of the functioning of multilevel platforms and their role in linking up value chain actors with the idea to support the development of such interventions in the future.

Eastwood C, Klerkx L and Nettle R. 2017. Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *Journal of Rural Studies* 49:1–12. doi: 10.1016/j.jrurstud.2016.11.008
Precision farming technologies represent an innovation challenge in terms of their diffusion into farming practice, and create a new dynamic for research and extension roles. The purpose of this paper is to examine the interaction and distribution of research and extension roles of public, private and agricultural industry organizations in precision farming innovation systems. We connect findings to the broader debates on role divisions of public and private research and extension in innovation systems. Two case studies were examined: (1) precision dairy farming in Australia and (2) the use of automatic milking systems in northwestern Europe. A timeline analysis method, underpinned by a functions of innovation systems framework, was used to examine activities of actors and organizations in the case studies.

There were three main findings: (1) Complex agricultural innovations require a collaborative approach for successful innovation and diffusion. The need for, and type of, collaboration differs across scales from farm-level (individual learning) to a national and global level with issues of skill training and service provider capability. Additionally, a threshold scale is required before the commercial sector can operate effectively. (2) The presence, and limitations, of private (commercial) interests and their position as a key knowledge

base in precision farming heightens the need for public research and extension organizations to promote collaborative innovation programs with technology companies. There is a key public or industry good role in providing "back office" activities to support and complement private "front office" activities. (3) Public and private research and extension organizations can work together; however there are areas where it makes more sense for one party or the other to lead. For precision farming systems, the roles for public organizations involve leadership on data integration (on-farm and off-farm), integration of technology (via standards), testing equipment performance, and development of training programs, including support of initiatives such as farmer clubs. The principle theoretical implication is that public, private and industry roles in research and extension should not be viewed as dichotomous (e.g. precompetitive/competitive), but as highly fluid in terms of the moments they are needed, and the scale at which they are needed, within the technological innovation system.

Eastwood C, Klerkx L, Ayre M and dela Rue B. 2019. Managing socio-ethical challenges in the development of smart farming: From a fragmented to a comprehensive approach for responsible research and innovation. *Journal of Agricultural and Environmental Ethics* 32(5):741–68. doi: 10.1007/s10806-017-9704-5

Smart farming (also referred to as digital farming, digital agriculture and precision agriculture) has largely been driven by productivity and efficiency aims, but there is an increasing awareness of potential socioethical challenges. The responsible research and innovation (RRI) approach aims to address such challenges but has had limited application in smart farming contexts.

Using smart dairying R&D in New Zealand as a case study, we examine the extent to which principles of RRI have been applied in New Zealand's smart dairying development and assess the broader lessons for RRI application in smart farming. We draw on insights from (i) a review of research on dairy technology use in New Zealand, (ii) interviews with smart dairying stakeholders and (iii) the application of an analytical framework based on RRI dimensions.

We conclude that smart dairying R&D and innovation activities have focused on technology development and on-farm use without considering socioethical implications and have excluded certain actors such as citizens and consumers. This indicates that readiness to enact RRI in this context is not yet optimal, and future RRI efforts require leadership by government or dairy sector organizations to fully embed RRI principles in the guidelines for large R&D project design (what has also been referred to as "RRI maturity"). More broadly, enacting RRI in smart farming requires initial identification of RRI readiness in a given sector or country and devising a roadmap and coherent project portfolio to support capacity building for enacting RRI. Additionally, methods (such as RRI indicators) for operationalizing RRI must be adapted to the context of the national or sectoral innovation system in which smart farming is being developed.

Edlmann FRP and Grobbelaar S. 2021. A framework of engagement practices for stakeholders collaborating around complex social challenges. *Sustainability* 13(19):10828. dx.doi.org/10.3390/su131910828

South Africa's interventions to address complex social challenges rely on coordination across several sectors and between different levels of government and society. Improved alignment, planning and coordination are needed when addressing the causal factors of these social challenges. These causal factors include the environments in which people live and their behaviors. Furthermore, emphasis is placed on the recurring engagement of civil society, especially of marginalized stakeholders, as participants in the efforts to address the challenges.

The study draws from the promise shown by stakeholder networks, termed innovation platforms, in other Sub-Saharan African countries to address such complex social challenges. The study aimed to improve the understanding of how a stakeholder network's engagement practices impact the effectiveness of the network. To this end, a conceptual framework and management tool for stakeholder engagement in innovation platforms is proposed. The study followed the conceptual framework analysis procedure to develop, evaluate and refine the conceptual framework. The article describes the core research outcomes

of the framework development approach, starting with a systematized literature review to identify core concepts, followed by interviews with experts and a case study to refine the framework content. The case study applied the framework to develop recommendations for improved engagement in a stakeholder network, which has been established around the challenge of vagrancy in Stellenbosch, South Africa.

The result of the approach is a multidimensional framework for conceptualizing stakeholder engagement practices in a variety of contexts. The focus of the framework content remains on the practices of engagement that enable effective and fruitful stakeholder interactions within and around a network. The study delivered valuable insights into the nature of some development initiatives in South Africa and the impact of stakeholder engagement on them.

Van Fossen K, Morfin J and Evans S. 2018. A local learning market to explore innovation platforms. *Procedia Manufacturing* 21:607–14. doi: 10.1016/j.promfg.2018.02.162
This research investigates the design of a unique innovation platform to support entrepreneurial growth. The premise of the platform is that the needs of institutions can be coupled with supply from early-stage businesses to enable the learning and growth of those businesses. We assume that some institutions are in a position to be more helpful and understanding about the setbacks encountered by early-stage businesses, and that the institutions' skillset and tolerance offers entrepreneurs an environment to learn and grow their businesses.

Many startups face competition from powerful multinational corporations that have the scale to reach consumers through inexpensive pricing, branding and reputation. The subset of startups with sustainability embedded into their ethos often has an even more difficult time competing with prices. This is especially apparent with food. Not all food is priced to accurately reflect its costs to society and the environment. For novice entrepreneurs, attempting to internalize some of these nonmonetary costs may seem too great a risk.

The proposed institution-based innovation platform might overcome some of these difficulties. To explore the possibilities of the platform, we combine a literature review and case study analysis. While existing innovation platform cases in the literature have been studied in retrospect, we introduce a novel approach that sets out to follow the design of a food innovation platform, referred to as the Local Learning Market, from the earliest stages of planning. Our findings point to the potential risk, trust and learning advantages of this particular platform. Entrepreneurs are able to experiment and develop their value proposition in a safe space, find viable customers and identify market niches. Researching the Local Learning Market is a first step in understanding whether similarly modeled platforms can increase the likelihood of success for startups pursuing sustainable business models in other sectors.

Gildemacher P and Mur R. 2012. Bringing new ideas into practice: Experiments with agricultural innovation. Learning from research into use in Africa (2). Amsterdam: KIT Publishers.
No abstract.

Heeks R, Foster C and Nugroho Y. 2014. 'New models of inclusive innovation for development.' *Innovation and Development* 4/2:175–85. doi: 10.1080/2157930X.2014.928982
This special issue of *Innovation and Development* focuses on inclusive innovation, specifically on analysis of the new models of this form of innovation that are emerging. After discussing the growing need for research into those models, this editorial paper interrogates the meaning of "inclusive innovation" and what it means to understand inclusive innovation in terms of models. The editorial then outlines the contribution of the papers that make up this special issue before drawing out some lessons for inclusive innovation policy and practice, and discussing future research priorities.

Homann-Kee Tui S, Adekunle A, Lundy M, Tucker J, Birachi E, Schut M, Klerkx L, Ballantyne P, Duncan A, Cadilhon J and Mundy P. 2013. What are innovation platforms? Innovation Platforms Practice Brief 1. Nairobi, Kenya: ILRI.
No abstract.

Hounkonnou D, Brouwers J, Van Huis A, Jiggins J, Kossou D, Röling N, Sakyi-Dawson O and Traoré M. 2018. Triggering regime change: A comparative analysis of the performance of innovation platforms that attempted to change the institutional context for nine agricultural domains in West Africa. *Agricultural Systems* 165:296–309. doi: 10.1016/j.agsy.2016.08.009
The article synthesizes the experiences of innovation platforms that engaged in open-ended experimental action to improve the institutional context for smallholder farm development in West Africa. The innovation platforms sought change at the level of the institutional regime covering an entire agricultural domain (such as cocoa, cotton, oil palm or water management). Their purpose was therefore not to "roll out" farm-level technologies across rural communities. The innovation platforms' outcomes were documented and analyzed throughout by means of theory-based process tracing in each of seven of the nine domains in which regime change was attempted. The evidence shows that by means of exploratory scoping and diagnosis, sociotechnical and institutional experimentation, and guided facilitation, innovation platforms can remove, bypass or modify domain-specific institutional constraints and/or create new institutional conditions that allow smallholders to capture opportunity. The article describes the 5-year, EUR 4.5 million research program in Benin, Ghana and Mali, covering theory, design, methods and results. It is the sequel to Hounkonnou et al. (2012).

Hounkonnou D, Kossou D, Kuyper TW, Leeuwis C, Nederlof ES, Röling N, Sakyi-Dawson O, Traoré M and Van Huis A. 2012. An innovation systems approach to institutional change: Smallholder development in West Africa. *Agricultural Systems* 108:74–83. doi: 10.1016/j.agsy.2012.01.007
Sustainable intensification of smallholder farming is a serious option for satisfying 2050 global cereal requirements and alleviating persistent poverty. That option seems far off for Sub-Saharan Africa, where technology-driven productivity growth has largely failed.

The article revisits this issue from a number of angles: (i) current approaches to enlisting Sub-Saharan African smallholders in agricultural development, (ii) the history of the phenomenal productivity growth in the US, the Netherlands and the Green Revolution Asia, and (iii) the current framework conditions for Sub-Saharan Africa's productivity growth. This analysis shows that (a) the development of an enabling institutional context was a necessary condition that preceded the phenomenal productivity growth in industrial and Green Revolution countries, and that (b) such a context is also present for successful Sub-Saharan Africa's export crop production, but that (c) the context is pervasively biased against Sub-Saharan Africa's smallholder food production.

The article traces the origins of technology supply push as a dominant paradigm that hinders recognition of the role of enabling institutions. The article then reviews the literature on institutional change and zooms in on innovation platforms as a promising innovation system approach to such change. We describe the concrete experience with innovation platforms in the Sub-Saharan African Challenge Programme and in the Convergence of Sciences: Strengthening Innovation Systems program. The former has demonstrated proof of concept. The latter is designed to trace causal mechanisms. We describe its institutional experimentation and research methodology, including causal process tracing.

Kilelu CW, Klerkx L and Leeuwis C. 2013. Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme. *Agricultural Systems* 118:65–77.
The agricultural innovation systems approach emphasizes the collective nature of innovation and stresses that innovation is a co-evolutionary process, resulting from alignment of technical, social, institutional and organizational dimensions. These insights are increasingly informing interventions that focus on setting up multistakeholder initiatives, such as innovation platforms and networks, as mechanisms for enhancing agricultural innovation, particularly in Sub-Saharan Africa. There has been much emphasis on how such platforms are organized, but only limited analysis unraveling how they shape co-evolution of innovation processes.

This paper addresses this gap and conceptualizes platforms as intermediaries that connect the different actors in innovation systems in order to foster effective co-evolution. We present a case study of a smallholder dairy development program in Kenya, led by a consortium of five organizations that provide a platform for building multi-actor partnerships to enhance smallholder dairy productivity and improve livelihoods. The findings indicate that co-evolution of innovation is a highly dynamic process with various interactional tensions and unexpected effects, and that the distributed nature of intermediation is important in resolving some of these tensions emerging at different actor interfaces. However, platforms are not always able to adapt adequately to emerging issues. This points to the need to look at platforms dynamically and pay more attention to mechanisms that strengthen feedback, learning and adaptive management in innovation processes.

Kilelu C, Klerkx L, Omore A, Baltenweck I, Leeuwis C and Githinji J. 2017. Value chain upgrading and the inclusion of smallholders in markets: Reflections on contributions of multi-stakeholder processes in dairy development in Tanzania. *European Journal of Development Research* 29(5):1102–21. doi: 10.1057/s41287-016-0074-z

Increasingly, value chain approaches are integrated with multistakeholder processes to facilitate inclusive innovation and value chain upgrading of smallholders. This pathway to smallholder integration into agri-food markets has received limited analysis. This article analyzes this integration through a case study of an ongoing smallholder dairy development program in Tanzania. Value chain upgrading and innovation systems perspectives were combined in an analytical framework to interpret the findings, which show that multistakeholder processes enhance horizontal and vertical coordination but limit process and product upgrading. The main conclusion is that, although such processes may catalyze smallholder market inclusion, their effects are largely bounded by existing value chain structures (e.g. production system, fragmented markets), timeframe and how prevailing institutional constraints are addressed, which may constrain the intentions of such collaboration action. This calls attention to the starting points of value chain interventions and the sociopolitical dynamics that are part of multistakeholder processes.

Klerkx L and Nettle R. 2013. Achievements and challenges of innovation co-production support initiatives in the Australian and Dutch dairy sectors: A comparative study. *Food Policy* 40:74–89. doi: 10.1016/j.foodpol.2013.02.004

Policymakers and innovation scholars share an increasing interest in how to operationalize innovation support given the increasing number and range of stakeholders engaged in co-producing innovation. Using comparative case study analysis, this article examines support initiatives for dairy sector innovation in the Netherlands and Australia, addressing common challenges such as environmental issues, cattle health, new technology and human resources.

To this end, a review was conducted of documented information and articles published on the initiatives. The qualitative analysis focused on how the co-production process was supported and the achievements and challenges associated with each case. Across both countries and between different initiatives, the main achievements were found to be the generation of very different ideas addressing dairy sector challenges and attempting to bridge public and private sector interests. The main challenges included maintaining effort and momentum for high ambition targets and the potential for duplication as stakeholders became enrolled in different initiatives sponsored by different organizations in an increasingly devolved institutional setting. Furthermore, without strong institutional support for innovation co-production processes, individual actors were less able to operate effectively in innovation co-production roles.

It is concluded that dairy sector innovation policies should address institutional constraints (e.g. provision of leadership and rewards for involvement in co-production processes), recognize that facilitation of innovation co-production needs to be adequately resourced, enhance support for initiative coordination to avoid duplication of effort, and take into account the specific institutional setting of countries and sectors to guide the design of innovation co-production support initiatives.

Klerkx L, Van Mierlo B and Leeuwis C. 2012. Evolution of systems approaches to agricultural innovation: Concepts, analysis and interventions. *In* Darnhofer I, Gibbon D and Dedieu B, eds. *Farming Systems Research into the 21st Century: The New Dynamic*. Dordrecht, the Netherlands: Springer. 457–83. doi: 10.1007/978-94-007-4503-2

Over the years, there has been an evolution of systemic thinking in agricultural innovation studies, culminating in the agricultural innovation systems perspective. In an attempt to synthesize and organize the existing literature, this chapter reviews the literature on agricultural innovation, with the threefold goal of (1) sketching the evolution of systemic approaches to agricultural innovation and unraveling the different interpretations, (2) assessing key factors for innovation system performance and demonstrating the use of system thinking in the facilitation of processes of agricultural innovation by means of innovation brokers and reflexive process monitoring, and (3) formulating an agenda for future research. The main conclusion is that the agricultural innovation systems perspective provides a comprehensive view on actors and factors that co-determine innovation, and in this sense allows understanding of the complexity of agricultural innovation. However, its holism is also a pitfall as it allows for many interpretations, which complicates a clear focus of this research field and the building of cumulative evidence. Hence, more work needs to be done conceptually and empirically.

Klerkx L, Aarts N and Leeuwis C. 2010. Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. *Agricultural Systems* 103(6):390–400. doi: 10.1016/j.agsy.2010.03.012

The purpose of this article is to investigate effective reformism: strategies that innovation networks deploy to create changes in their environment in order to establish a more conducive context for the realization and durable embedding of their innovation projects. Using a case study approach, effective reformism efforts are analyzed in a technological innovation trajectory related to the implementation of a new poultry husbandry system and an organizational innovation trajectory concerning new ways of co-operation among individual farms to establish economies of scale. The findings reinforce the idea, emerging from a complexity perspective on agricultural innovation systems, that interaction between innovation networks and their environment is only steerable to a limited extent.

Nonetheless, innovation networks can enhance effective reformism by creating tangible visions that serve as vehicles to create understanding about the innovation and mobilize support for it, and by employing several kinds of boundary-spanning individuals that are able to forge effective connections between innovation networks and their environment. Because innovation networks can only partially influence their institutional environment, and because unintended consequences of actions and random events influence the course of the innovation process, innovation network actors need to continuously reinterpret the contexts in which they move. This constant reflection by the innovating actors on their position vis-à-vis their environment needs to be supported by dedicated facilitators and monitoring and evaluation methods aimed at system learning. This implies that agricultural innovation policies should, instead of aiming to fully plan and control innovation, foster the emergence of such flexible support instruments that enable adaptive innovation management.

Kobicheva A, Baranova T and Tokareva E. 2020. The development of an interaction mechanism between universities and other innovation system actors: Its influence on university innovation activity effectiveness. *Journal of Open Innovation: Technology, Market, and Complexity* 6(4):109. dx.doi: 10.3390/joitmc6040109

Objectives: The innovative economy is based on effective interaction between the scientific and educational sphere and the business environment, free flow of innovative ideas, and active commercialization of developments in order to constantly update and develop the domestic economy through new technologies. At the moment, a model of effective interaction between universities, business structures and government in Russia has not been built. This research is aimed to develop a mechanism for multilateral interaction between universities and other participants in the innovation system, which ensures the activation of scientific and innovative activities, acceleration of the transfer process, and effective commercialization of innovative ideas.

Methods: To evaluate the effectiveness of the offered interaction mechanism based on the open innovation platform, we conducted a complex multicriteria assessment of forecast indicators of a university's innovation activity effectiveness. We conducted two online surveys. Heads of scientific laboratories at the university (N = 4) and representatives of business (N = 3) acted as experts. The first survey was intended to indicate the weight of innovation activity indicators reflecting the significance of these indicators in the framework of innovation development. In the second survey, experts defined the forecast indicators of the university's innovation activity after implementation of the proposed interaction mechanism.

Results: The conducted study revealed the importance of enhancing cooperation between universities and other innovation system actors for achieving higher results of innovation activity. The calculation of the effectiveness of the offered interaction mechanism showed positive influence on the university's innovation activity indicators. Thus, the mechanism can be used by multidisciplinary universities to increase their innovation activity indicators as well as the potential of all interacting entities.

Lundy M, Cadilhon J, LeBorgne E, Birachi E, Cullen B, Boogaard B, Adekunle A and Victor M. 2013. Monitoring innovation platforms. Innovation Platforms Practice Brief 5. Nairobi, Kenya: ILRI.
No abstract.

Marais A, Meyer I, Kennon D, Herselman M and Grobbelaar S. 2020. Supporting the formation and functioning of innovation platforms in healthcare value chains. *Science and Public Policy* 48:1–17. doi: 10.1093/scipol/scaa061
Rising patient demands, a growing population and resource limitations constrain the South African healthcare system. The integration of disparate interventions that are developed and implemented across various actors in healthcare value chains remains a significant challenge. This calls for a multidisciplinary approach to integrate the knowledge of communities, NGOs, private sector actors, frontline healthcare workers, and researchers in the development of sustainable, value-adding interventions. Multistakeholder engagement, in this article referred to as innovation platforms, is a mechanism through which interdependent value chain actors could be organized and coordinated to develop sustainable innovations to strengthen the healthcare system.

This article addresses the lack of guidance on how to develop and operate healthcare innovation platforms in South Africa by presenting a framework for innovation platform formation and functioning in healthcare value chains. A grounded theory approach, namely conceptual framework analysis, informed framework development within an exploratory qualitative study. The outcome of the study is an innovation management tool for improved policy development in a developing country context. It provides practical guidance to policymakers on how to (i) setup and develop an innovation platform, (ii) implement interventions to improve innovation platform functioning and (iii) develop mechanisms to address commonly experienced challenges.

Prahalad CK. 2012. 'Bottom of the pyramid as a source of breakthrough innovations.' *Journal of Product Innovation Management* 29/1:6–12. doi: 10.1111/j.1540-5885.2011.00874.x
In this paper, I identify the bottom of the pyramid (BOP) markets as a new source of radical innovation. By focusing managerial attention on creating awareness, access, affordability and availability (4As), managers can create an exciting environment for innovation. I suggest that external constraints can be utilized to build an innovation sandbox within which new products and business models can be created. Using a live example of such an innovation—the development of the biomass stove for the rural poor in India—I illustrate the process and the usefulness of the approach. Increasingly, global firms are recognizing the implications of innovations at the BOP for developed markets as well.

Schut M, Klerkx L, Sartas M, Lamers D, Campbell MMC, Ogbonna I, Kaushik P, Atta-Krah K and Leeuwis C. 2016a. Innovation platforms: Experiences with their institutional embedding in agricultural research for development. *Experimental Agriculture* 52(4):537–61. doi: 10.1017/S001447971500023X

Innovation platforms are seen as a promising vehicle to foster a paradigm shift in agricultural research for development (AR4D). By facilitating interaction, negotiation and collective action between farmers, researchers and other stakeholders, innovation platforms can contribute to more integrated, systemic innovation that is essential for achieving agricultural development impacts.

However, successful implementation of innovation platforms requires institutional change within AR4D establishments. The objective of this paper is to reflect on the implementation and institutionalization of innovation platforms in present AR4D programs. We use experiences from Sub-Saharan Africa to demonstrate how the adoption and adaptation of innovation platforms creates both opportunities and challenges that influence platform performance and impact. Niche-regime theory is used to understand challenges and anticipate how to deal with them. A key concern is whether innovation platforms in AR4D challenge or reinforce existing technology-oriented agricultural innovation paradigms. For example, stakeholder representation, facilitation and institutional embedding determine to a large extent whether the innovation platforms can strengthen systemic capacity to innovate that can lead to real paradigm change, or are merely "old wine in new bottles" and a continuation of "business as usual." Institutional embedding of innovation platforms and—more broadly—the transition from technology-oriented to system-oriented AR4D approaches require structural changes in organizational mandates, incentives, procedures and funding, as well as investments in exchange of experiences, learning and capacity development.

Schut M, Van Asten P, Okafor C, Hicintuka C, Mapatano S, Nabahungu NL, Kagabo D, Muchunguzi P, Njukwe E, Dontsop-Nguezet PM et al. 2016b. Sustainable intensification of agricultural systems in the Central African Highlands: The need for institutional innovation. *Agricultural Systems* 145:165–76. doi: 10.1016/j.agsy.2016.03.005

This study identifies entry points for innovation for sustainable intensification of agricultural systems. An agricultural innovation systems approach is used to provide a holistic image of (relations between) constraints faced by different stakeholder groups, the dimensions and causes of these constraints, and intervention levels, timeframes and types of innovations needed. Our data shows that constraints for sustainable intensification of agricultural systems are mainly of economic and institutional nature. Constraints are caused by the absence or poor functioning of institutions such as policies and markets, limited capabilities and financial resources, and ineffective interaction and collaboration between stakeholders.

Addressing these constraints would mainly require short- and middle-term productivity and institutional innovations, combined with middle- to long-term natural resource management (NRM) innovations across farm and national levels. Institutional innovation (e.g. better access to credit, services, inputs and markets) is required to address 69 percent of the constraints for sustainable intensification in the Central Africa Highlands. This needs to go hand in hand with productivity innovation (e.g. improved knowhow of agricultural production techniques, and effective use of inputs) and NRM innovation (e.g. targeted nutrient applications, climate-smart agriculture). Constraint network analysis shows that institutional innovation to address government constraints at national level related to poor interaction and collaboration will have a positive impact on constraints faced by other stakeholder groups.

We conclude that much of the R4D investments and innovation in the Central Africa Highlands remain targeting household productivity at farm level. Reasons for that include (i) a narrow focus on sustainable intensification, (ii) institutional mandates and pre-analytical choices based on project objectives and disciplinary bias, (iii) short project cycles that impede work on middle- and long-term NRM and institutional innovation, (iv) the likelihood that institutional experimentation can become political, and (v) complexity in terms of expanded systems boundaries and measuring impact.

Schut M, Cadilhon JJ, Misiko M and Dror I. 2018. Do mature innovation platforms make a difference in agricultural research for development? A meta-analysis of case studies. *Experimental Agriculture* 54(1):96–119. doi: 10.1017/S0014479716000752

Innovation platforms have become a popular vehicle in AR4D. The innovation platforms promise is that integrating scientific and local knowledge results in innovations that can have impact at scale. Many studies have uncovered how innovation platforms work in various countries, value chains and themes. The conclusion is clear: innovation platforms generate enthusiasm and can bring together stakeholders to effectively address specific problems and achieve "local" impact. However, few studies focus on "mature" innovation platforms and whether or not these achieve impact at a "higher" scale: address systems trade-offs to guide decision-making, focus on integration of multiple commodities, reach a large number of beneficiaries and learn from their failures.

This study evaluates the impact of mature innovation platforms in AR4D by analyzing the success factors of eight case studies across three continents. Although we found pockets of innovation platform success and impact, these were rarely achieved at scale. We therefore critically question the use of innovation platforms as a technology dissemination and scaling mechanism in AR4D programs that aim to benefit the livelihoods of many farmers in developing countries.

Nevertheless, we do find that innovation platforms can fulfill an important role in AR4D. If the innovation platform processes are truly demand-driven, participatory and based on collective investment and action, they have the ability to bring together committed stakeholders, and result in innovations that are technically sound, locally adapted, economically feasible for farmers, and socially, culturally and politically acceptable.

Several of our cases show that if these innovation platforms are firmly embedded in other public and private extension mechanisms and networks, they can allow the technologies or other types of innovations to scale out beyond the original innovation platform scope, geographical focus or target audience. We see a need for more rigorous, accurate and continuous measurement of innovation platform performance that can contribute to adaptive management of innovation platforms, better understanding of "what works" in terms of process design and facilitation, as well as to cost-benefit analysis of innovation platforms as compared to other approaches that aim to contribute to agricultural development.

Schut M, Kamanda J, Gramzow A, Dubois T, Stoian D, Andersson JA, Dror I, Sartas M, Mur R, Kassam S et al. 2019. Innovation platforms in agricultural research for development: Ex-ante appraisal of the purposes and conditions under which innovation platforms can contribute to agricultural development outcomes. *Experimental Agriculture* 55(4):575–96. doi: 10.1017/S0014479718000200

Innovation platforms are fast becoming part of the mantra of agricultural research for development projects and programs. Their basic tenet is that stakeholders depend on one another to achieve agricultural development outcomes, and hence need a space where they can learn, negotiate and coordinate to overcome challenges and capture opportunities through a facilitated innovation process.

Although much has been written on how to implement and facilitate innovation platforms efficiently, few studies support ex-ante appraisal of when and for what purpose innovation platforms provide an appropriate mechanism for achieving development outcomes, and what kinds of human and financial resource investments and enabling environments are required. Without these insights, innovation platforms run the risk of being promoted as a panacea for all problems in the agricultural sector.

This study makes clear that not all constraints will require innovation platforms and, if there is a simpler and cheaper alternative, that should be considered first. Based on the review of critical design principles and plausible outcomes of innovation platforms, this study provides a decision support tool for research, development and funding agencies that can enhance more critical thinking about the purposes and conditions under which innovation platforms can contribute to achieving agricultural development outcomes.

Sobratee N and Bodhanya S. 2017. How can we envision smallholder positioning in African agribusiness? Harnessing innovation and capabilities. *Journal of Business and Retail Management Research* 12:119–32. doi: 10.24052/JBRMR/V12IS01/HCWESPIAAHIAC
The intricate nature of the African agricultural-food system and the related multisectoral value chains capability challenges means that efforts to transform the current landscape to achieve food security in developing countries cannot escape complexity. A burgeoning body of research that uses the innovation systems approach to drive agricultural development in developing countries is emerging.

In this article, we argue that social agro-entrepreneurship has the potential to create the possibility space to make smallholder ventures sustainable. This can be achieved via a collective approach to transformation provided within agricultural innovation platforms. The development of agribusiness capabilities is considered from the complexity science perspective. We draw an analogy from the theoretical framework provided by the Leadership Capabilities Model of Hazy (2006) to explain how strategic institutional entrepreneurship can co-evolve toward fit within innovation platforms by harnessing capabilities simultaneously across sectors and at different levels through adaptive governance. Cross-sector partnerships are important to leverage the transformation of the smallholder sector toward stable ventures.

Spielman D, Ekboir J and Davis K. 2009. Developing the art and science of innovation systems enquiry: Alternative tools and methods, and applications to Sub-Saharan African agriculture. *In* Sanginga P, Waters-Bayer A, Kaaria S, Njuki J and Wettasinha C, eds. 2008. *Innovation Africa: Enriching Farmers' Livelihoods*. London: Earthscan. 72–88.
No abstract.

Stilgoe J, Owen R and Macnaghten P. 2013. Developing a framework for responsible innovation. *Research Policy* 42(9):1568–80. doi: 10.1016/J.RESPOL.2013.05.008
The governance of emerging science and innovation is a major challenge for contemporary democracies. In this paper we present a framework for understanding and supporting efforts aimed at "responsible innovation." The framework was developed in part through work with one of the first major research projects in the controversial area of geoengineering, funded by the UK Research Councils. We describe this case study, and how this became a location to articulate and explore four integrated dimensions of responsible innovation: (1) anticipation, (2) reflexivity, (3) inclusion and (4) responsiveness. Although the framework for responsible innovation was designed for use by the UK Research Councils and the scientific communities they support, we argue that it has more general application and relevance.

Swaans K, Cullen B, Van Rooyen A, Adekunle A, Ngwenya H, Lema Z and Nederlof S. 2013. Dealing with critical challenges in African innovation platforms: Lessons for facilitation. *Knowledge Management for Development Journal* 9(3):116–35. http://journal.km4dev.org/
Innovation platforms are increasingly used by research and development initiatives to actively engage the poor in agricultural innovation processes. These platforms are forums for action and learning, where different types of actors come together to address issues of mutual concern. However, the dynamic nature of the innovation process, and the differences in interest, capacity and power among the actors involved, pose a challenge in the facilitation of these platforms. We believe that the key to success is very much linked to the attitude, skills and capacities of the innovation broker.

This paper highlights seven key issues that in our view are critical to effective platform facilitation and have not received the attention they deserve: (1) the dynamic and evolving nature of platforms, (2) power dynamics, (3) gender equity, (4) external versus internal facilitation, (5) sustainability of the process, (6) issues of scale and (7) monitoring and evaluation. These issues and implications for facilitation of innovation platforms will be discussed based on examples from the field and in relation to current theories.

Van Ewijk E and Ros-Tonen MAF. 2021. The fruits of knowledge co-creation in agriculture and food-related multi-stakeholder platforms in sub-Saharan Africa: A systematic literature review. *Agricultural Systems* 186:102949. doi: 10.1016/j.agsy.2020.102949
Food insecurity and the weak position of smallholders in food value chains are key challenges in many low- and middle-income countries in Sub-Saharan Africa. In order to increase food security and make agricultural value chains more inclusive, donors, governments and researchers increasingly stimulate partnerships between multiple actors, in which knowledge exchange, joint learning and knowledge co-creation play a central role in reducing the time lag between research findings and their translation into practical outcomes. Yet, despite the growing body of literature on multi-actor and cross-sector learning in these partnerships, an overview of existing literature and a strong evidence base of results of knowledge co-creation in these platforms is missing.

Based on a systematic literature review, this paper documents existing evidence of knowledge co-creation processes in multistakeholder platforms (MSPs) in Sub-Saharan Africa. Findings reveal, first, many examples of positive results, including increased yields and income for farmers; policy, regime and institutional changes; and changes in environmental sustainability. Second, there are several limitations to what MSPs can achieve, including limited attention for scaling up and a lack of sustainability due to dependency on donor funding. Third, there are limitations related to the evidence base: there is a tendency to report less on failures, and available findings on the effectiveness of MSPs are mixed. Considering the evidence base, we conclude that there is a need to systematically document, report and assess MSPs and not take their effectiveness for granted. A systematic literature review thereby has an important added value because the critical assessment of methodological rigor increases the credibility of results documented in the included studies.

Van Paassen A, Klerkx L, Adu-Acheampong R, Adjei-Nsiah S and Zannoue E. 2014. Agricultural innovation platforms in West Africa. How does strategic institutional entrepreneurship unfold in different value chain contexts? *Outlook on Agriculture* 43(3):193–200. doi: 10.5367/oa.2014.0178
Inspired by innovation system theory, donors promote innovation platforms to enhance collaboration for development. However, innovation platform practice and impact are diverse: hence the question arises of whether and how innovation platform approaches are able to create institutional change for the benefit of smallholders.

The authors present the experience of an action research program in West Africa and analyze the cases from a dialectic perspective on institutional entrepreneurship. The results show that a researcher-initiated open innovation platform approach with clear principles and in-depth analysis of the value chain context is able to create reasonably effective innovation platform coalitions for smallholder development. In a mature value chain, it may be possible to mobilize high-level actors, but innovation platforms often start at a lower level and apply a two-pronged approach. They focus primarily on research and communication to improve smallholder technical and entrepreneurial practices, while diligently mobilizing high-level actors to attain critical regulatory and/or market support. Mobilization success is limited in contentious environments.

Woodhill J. 2010. Capacities for institutional innovation: A complexity perspective. *IDS Bulletin* 41(3):47–54.
Many capacity development interventions have been driven by the needs of technological innovation rather than the needs of institutional innovation. However, this article argues that the global challenges of the twenty-first century call for institutional innovation that entails a very different dynamic of the relations within society. Changing institutions, be it related to societal norms and values, government policies, market incentives, political systems or organizational processes, requires the "soft" capacities of communication, trust building, diplomacy, networking, making sense of messy social situations, political advocacy and leadership. The article concludes by outlining four specific capabilities required for institutional innovation: (1) navigating complexity, (2) learning collaboratively, (3) engaging politically and (4) being self-reflective.

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