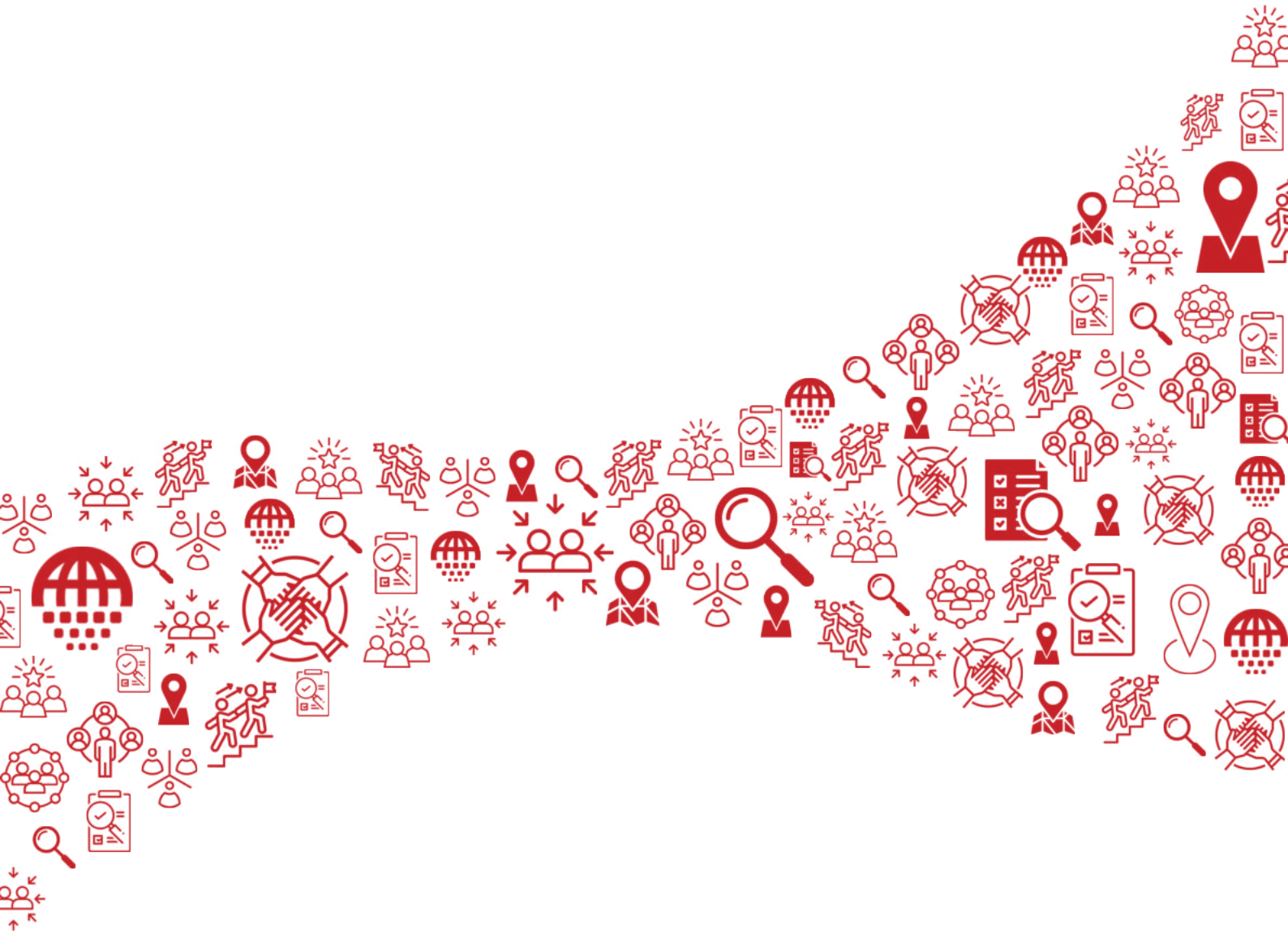
Urban Living Labs as Tools for a Just Transition

Adapting the Living Lab Approach into the Development Cooperation Context



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Wuppertal Institut

UN HABITAT FOR A BETTER URBAN FUTURE

Urban Living Lab CENTER

Cities CHALLENGE 2.0

City WORKS Localising Global Agendas

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EXECUTIVE SUMMARY

Cities are dynamic and multifaceted environments with interconnected social, economic, and environmental issues that require innovative and participatory solutions. The rationale behind urban living labs stems from the recognition that traditional top-down and fragmented approaches to urban development and problem-solving often fall short of addressing the complexities of urban challenges. The importance and urgency of sustainability and climate change mitigation and adaptation are increasingly recognised and emphasised. Governments at all levels must urgently take action to address sustainability challenges. Implementing solutions can be complex because they require transformations likely to be contested or coordination between actors still working in silos.

Collaboration and support are crucial to identify and implement sustainable and inclusive solutions. Bringing all key actors together can address the challenges of knowledge and fragmentation of responsibilities. Urban Living Labs (ULLs) can help with that and provide a platform for heterogeneous stakeholders, including government agencies, academia, businesses, community organisations, and residents, to learn and co-create innovative solutions that are then tested in real-world urban contexts. By involving diverse actors and stakeholders, living labs tap into their collective knowledge, expertise, and resources, fostering collaboration and boosting buy-in. Actual physical experimentation is critical as it allows feedback and potential iterations, tests the viability and with that provides a basis for scale-up and replication.

Living labs operate within the real-life urban environment, allowing for the testing, experimentation, and validation of innovative ideas, technologies, and services. This iterative process facilitates learning, adaptation, and continuous improvement of solutions, ensuring they are well-suited to urban challenges' complex and dynamic nature. Urban living labs also create open innovation spaces where solutions can be tested with. This cross-sectoral collaboration promotes a culture of innovation and fosters the emergence of novel approaches to urban development. By breaking down silos and promoting interdisciplinary collaboration, living labs encourage the integration of diverse perspectives and expertise.

Characteristics of an Urban Living Lab

Typically, five principles should characterise an Urban Living Lab:

- Geographical embeddedness, i.e., mostly through physical environments, without various urban configurations possible depending on the project.

- Learning about an innovation (e.g., new products, services, technologies, applications, processes, and policies) before testing it to test its adaptation to the local context or identify the need for iterations. Furthermore, urban living labs create open innovation spaces, where stakeholders can freely

exchange ideas, knowledge, and resources. This cross-sectoral collaboration promotes a culture of innovation and fosters the emergence of novel approaches to urban development.

- Participation from four groups typically: users or the product or citizens playing a key role in experimentation, public entities, knowledge institutes, and private actors. By breaking down silos and promoting interdisciplinary collaboration, living labs encourage the integration of diverse perspectives and expertise. The participatory nature of urban living labs enables stakeholders to actively engage in the design, development, and implementation of solutions, ensuring that the interventions are contextually relevant, effective, and sustainable. This collaborative approach empowers communities and fosters a sense of ownership and commitment to the urban development process.

- Leadership and ownership, as Urban Living Labs benefit from central coordination and local champions, while the decision-making power of all participations should be ensured.

- Evaluation and refinement as critical steps to producing knowledge, evaluating the innovation, and diffusing it when successful by scaling up or replicating it in other geographies. This iterative process facilitates learning, adaptation, and continuous improvement of solutions, ensuring they are well-suited to urban challenges' complex and dynamic nature.

A large diversity of Urban Living Labs can be found around variables of the lab's goal, the topic(s), the scope, and the context. This diversity is sensible as it reflects the diversity of the local needs and focus areas.

Benefits of Urban Living Labs

Due to their collaborative, participatory, and experimental approach, urban living labs are valuable for promoting sustainable and innovative urban development. Below are some of the main benefits of urban living labs:

- Cooperation between heterogeneous and complementary stakeholders.

- Flexibility and temporary interventions to test an innovation.

- Test an innovation existing in other locations to analyse its fitness to the local context or create an entirely new solution, idea or technology adapted to the local context.

- Integrate solid impact assessment and monitoring as a basis for the sustainability of the pilot, scale, and replication of successful components.

Yet, Urban Living Labs are also not without challenges, including maintaining commitment from all partners or financial resources over time, communication challenges between heterogeneous partners or conflicting views and expectations.

Typical structure of an Urban Living Lab

To integrate all the elements discussed on ULLs , we propose a framework with 5-Is, standing for Inform, Inspire, Initiate, Implement and Impact.

- Inform focuses on developing the capacities of the stakeholders involved in the ULL and increasing the awareness of all stakeholders related to the topic.

- Inspire encourages decision-makers to take up innovative approaches to conceptualising and developing ULL in their local context.

- Initiate consists of strategies that allow for developing solutions in the ULL to an identified problem.

- Implement focuses on implementing pilot activities where the solutions developed are tested.

- Impact focuses on developing strategies and tools that will allow the assessment of the ULL and allow for scale-up and replication.

Urban Living Labs in a development cooperation context

Most development cooperation activities include supporting national, sub-national and local decision-makers in developing strategies and solutions that address social, environmental, and economic issues. Participatory approaches are often employed in identifying and replicating solutions in the target countries. While participatory approaches are effective, key constraints exist, such as centralised decision-making and power dynamics. For the rapidly changing urban issues, we will need solutions that can be tested, revised and adapted to local needs. Such an approach will benefit the development cooperation in efficiently utilising the resources available for the project and also bring local accountability and responsibility to the developed solution.

The ULL approach builds upon the participatory approaches and introduces the experimentation element into developing solutions. As seen earlier, an ULL is an iterative process and needs inputs from all the relevant stakeholders in developing solutions. Knowledge development and learning are embedded into the ULL approach. The ULLs enable the local stakeholders to develop consensual solutions for all parties involved. The scaling-up and replication is an element that needs consideration while developing the solution. Several development

cooperation activities are beginning to use the word “Lab” or “Living Lab” in their initiatives, yet they often miss some of the core components of an Urban Living Lab that fully embraces the inclusive co-development approach.

Implementing the ULL approach in development cooperation

Participatory Urban Living Labs can be a helpful tool to foster a Just Transition in the context of development cooperation. As development cooperation activities often do already incorporate participatory approaches, there is an opportunity to incorporate the ULL approach further into development cooperation projects:

- Map key objectives and needs of key co-development actors and stakeholders in project concepts and involve them in the project design.
- Explicitly include the ULL approach in activities and closely involve co-development partners in the project implementation.
- Engage with a diverse set of stakeholders. This includes involving local businesses, entrepreneurs, and embed a Living Lab support and facilitation structure at a local academic institution.
- Contextualise the approach by analysing the socio-economic, cultural, and environmental factors.
- Promote the development of a shared vision. The current participatory approaches can be used.
- Focus on developing solutions through a co-creation methodology, such that there is collective ownership of the solution.
- Invest in improving the local capacity of the stakeholders to conceptualise, develop, implement, and monitor the solutions.
- Creating an environment for iterative learning – active feedback is a crucial element for this.
- Embed long-term sustainability as an element right from the start of the project, thereby enabling the stakeholders to consider innovative financing and partnership options.

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APRILab - American Political Reform & Innovation Lab

BHTrans - Belo Horizonte Transport

BMU - German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

BMWK - German Federal Ministry for Economic Affairs and Climate Action

BMZ - German Federal Ministry of Economic Cooperation and Development

BRT - Bus Rapid Transit

CE - Circular Economy

CODATU - Cooperation for Urban Mobility in Developing World / Coopération pour le Développement et l'Amélioration des Transports Urbains

DART - Dar-es-Salaam Rapid Transit Agency

DLR - German Aerospace Centre

UNU-EHS - United Nations University – Institute for Environment and Human Security

ENOLL - European Network of Living Labs

GIZ - German Agency for International Cooperation GmbH / Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GPS - Global Positioning Systems

IDIADA - Institute for Applied Automotive Research

IDOS - German Institute of Development and Sustainability

IIED - International Institute for Environment and Development

IKI - International Climate Initiative

INAS - Institute for Applied Sustainability

IP - Intellectual property

ISI - Fraunhofer Institute for Systems and Innovation Research

ISOE - Institute for Social-Ecological Research / Institut für sozial-ökologische Forschung

IT - Information Technology

ITDP - Institute for Transportation and Development Policy

JPI - Joint Programming Initiatives

KPI - Key Performance Index

LL - Living Lab

MENA - Middle East and North Africa

MIT - Massachusetts Institute of Technology

NBS - Nature Based Solutions

NGO - Non-Governmental Organisation

POLIS - Network of European cities and regions cooperating for innovative transport solutions

SDSN - Sustainable Development Solutions Network

SESA - Smart Energy Solutions for Africa

TUB - Technical University of Berlin

TUC - Transformative Urban Coalitions

TUEWAS - Transport, Environment, Energy and Water in Asia

TUMI - Transformative Urban Mobility Initiative

UBA - German Environmental Agency / Umweltbundesamt

UEMI - Urban Electric Mobility Initiative

ULL - Urban Living Lab

ULLC - Urban Living Lab Center

UN - United Nations

UNLab - Urban Nature Labs

UNILAG - University of Lagos

UNU - United Nations University

WITS - University of the Witwatersrand

WRI - World Resources Institute

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1. INTRODUCTION

Urban Living Labs represent an emerging approach of participatory co-development processes to test and validate innovation in the sustainable urban development context. In comparison to other participatory forms, the approach brings the advantage of focusing on co-creation involving a wide diversity of stakeholders and going beyond mere consultation and participation in real-world experimentation of innovation (products, services, technologies, applications, processes, or policies) to test the innovation's fitness to the local context or the need for adaptation and iteration, and lastly on the possibility to scale and replicate pilots. Urban Living Labs differ from other living labs by focusing on the urban area, implying spatial embeddedness, e.g., in the form of an intervention in a neighbourhood, and concentrating on sustainability challenges and solutions culminating and intersecting in cities.

Co-creation represents an essential premise of Urban Living Labs. Participatory decision-making aims at recognising and accepting an unavoidable plurality of standpoints. Decision-making balances compromise and consensus. As pointed out by Habermas, striving for common interest leads to consensus and striving for individual interest leads to compromise. Thus, participation plays an essential role, and the involvement of various groups is key to the success of an innovation.

Urban Living Labs do not limit themselves to co-creation: a core element of Urban Living Lab is the focus on testing or experimenting, an innovation in real-life conditions. In that sense, co-creation is applied at various stages of co-design, testing, possible iterations, and long-term monitoring to assess to what extent the tested innovation is adapted to the local context or needs adaptation and iteration.

In addition, since Urban Living Labs address innovation typically not familiar to all lab members, a key component is capacity-building, bringing knowledge to lab members first to empower them to go into the subsequent phase of co-design, experimenting and monitoring.

Leaning on these characteristics, Urban Living Labs are seen as a pathway to bring long-term effects on sustainability transitions, as they enable to overcome stakeholder fragmentation, diffuse knowledge and provide a flexible platform for innovation experimentation. The leeway left for adaptation of the tested innovation, combined with sufficient monitoring, provides a safer ground ensuring that pilots will not be a simple short-term measure. Replication and diffusion of Urban Living Labs support the persistence beyond the pilot stage, fostering long-term urban sustainability. Lastly and critically, Urban Living Labs explicitly aim at answering sustainability issues concentrated in cities, thereby contributing to Just Transition.

Urban Living Labs are currently mostly found in the Global North . They have been strongly applied in Europe in the last two decades, supported by funding

calls from the European Commission. Contrarily, Living Labs, particularly Urban Living Labs, are less established in the Global South.

This gap represents an enormous opportunity, which led to the creation of the Urban Living Lab Center (ULLC), allowing collaboration among implementation-oriented projects under an Urban Living Lab approach, focusing on urban climate action, the delivery of urban basic services and their intersections. The Urban Living Lab Center is the first Collaborating Center of the United Nations Human Settlements Programme (UN-Habitat). It is co-hosted by the Wuppertal Institute, the Massachusetts Institute of Technology (MIT) and the Technical University Berlin (TUB).

In the context of a lower diffusion of Urban Living Labs in the Global South, and development cooperation in particular, the Urban Living Lab Center is providing scientific support to German development cooperation partners to provide a more comprehensive Urban Living Labs approach to help partners assess their projects (Cities CHALLENGE, City WORKS) against the Urban Living Lab approach, and to provide a unified method for implementation, scaling-up and replication of promising, proven and acceptable solutions. This methodology document summarises the definitions and characteristics of Urban Living Lab approaches, the challenges in implementing them, the stakeholders and their involvement, pathways to implement Urban Living Lab, and case studies of Urban Living Labs, before coming to the assessment of German development cooperation projects against the approach of Urban Living Labs and recommendations.

This document leans on a three-pronged methodology to collect information about Urban Living Labs, which includes a review of corresponding academic literature, and technical, and policy reports, followed by desk research on applied Urban Living Labs, completed by the feedback gathered from experiences of ULLC partners in implementing Urban Living Labs across the world.

This report is organised as follows. Theoretical aspects of Sustainable Transitions are laid out in Section 2 (Transformation Pathways) as a rationale for the urban living labs approach. Fundamentals of Urban Living Labs are detailed in Section 3 (Living Labs). This includes Definitions, Principles, Typologies, Case Studies of Urban Living Labs and Challenges. The importance of stakeholder engagement is treated in Section 4. (Stakeholder Engagement). Section 5 (Systematic Approach to Development and Co-creation) presents the framework of the 5 I's, which stand for Inform, Inspire, Initiate, Implement, Impact – the how is detailed in the respective section. The assessment of the potential to apply an Urban Living Lab approach in German Development Cooperation, of challenges and gaps, is addressed in Section 6 (Urban Living Labs in German Development Cooperation). In Section 7, we provide recommendations on the elements that can be incorporated into existing development cooperation to highlight an urban living lab approach.

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2. TRANSFORMATION PATHWAYS

The urgency of sustainability and climate change demands swift action from governments. Though the future may be uncertain, solutions must be implemented without delay. The challenge lies in coordinating efforts between stakeholders, but it is a barrier that can be overcome.

For example, the implementation of low-carbon transport in cities, such as the introduction of electric vehicles, presents a multitude of challenges involving various stakeholders, including private companies, government authorities, users, and knowledge organizations. Despite this, communication and collaboration among them are often lacking, leading to an imbalance in access to data and knowledge about the industry's evolutions. As a result, sustainability transitions may not be optimized, and products developed may not prioritize the needs of all stakeholders or integrate the needs of transport users, especially in the Global South.

Collaboration and support – ideally from all in society – are crucial to attaining workable solutions. Bringing different types of actors together can address the challenges of knowledge and fragmentation of responsibilities.

In academia, transition studies have been looking at ways to promote sustainable production and consumption models by influencing current socio-technical systems Sustainability transitions refer to long-term transformation processes with a multidimensional perspective aimed at achieving more sustainable socio-technical systems.

Sustainability transitions involve different fields and sectors. It is a process where a complex system moves towards a more sustainable state. The process occurs in four phases: predevelopment, take-off, acceleration, and stabilisation (see Figure 1).

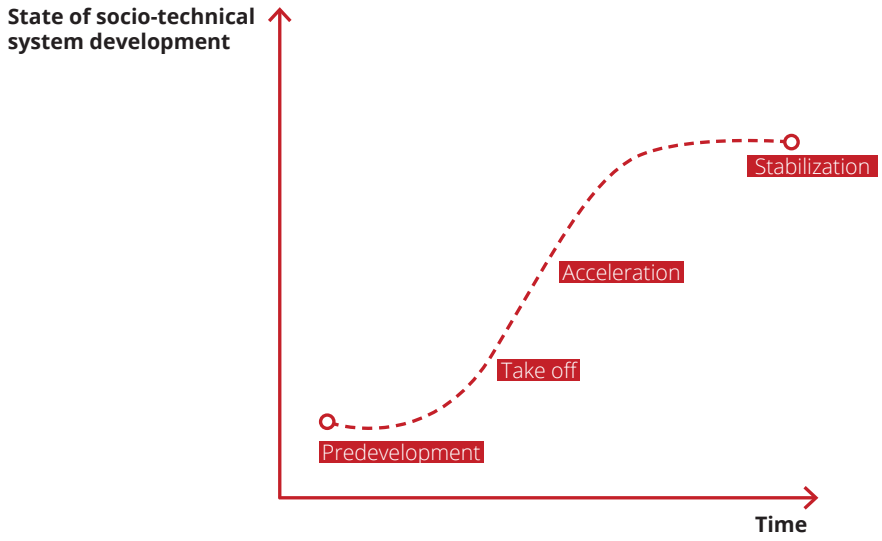

Figure 1: The phases of sustainability transition (Source: Binder et al., 2017)

It should be noted that transition and transformation are not synonyms but interrelated and interdependent concepts (Hölscher et al., 2018). Transition refers to a change of state; e.g., melting ice represents a transition from a solid into a liquid state. Transformation refers to a stark change of shape and character, e.g., the metabolism transforms substances.

In the sustainability context, transition focuses on improving efficiency, reducing waste, and increasing sustainability within the current system. At the same time, transformation aims to completely overhaul the current system to create a more sustainable system (Loorbach et al., 2017). Both transition and transformation are necessary for achieving sustainability, but they require different approaches and strategies. For a transformation to happen, there is a need for a series of transitions. Facilitating the transition towards a more sustainable operation can be simplified by applying a strategic framework offered by transitions management.

Transitions management is a methodical and intentional way of guiding the move towards sustainability. The approach prioritises encouraging innovation, collaboration, and learning among all those involved in the process (Loorbach, 2007). Participation is crucial in creating a shared vision and developing strategies to reach that goal. This approach prioritises collaboration and inclusivity (Kemp et al., 2007). It acknowledges that sustainability issues are often deeply ingrained in social, economic, and political systems and address the necessity for systemic change (Schot & Geels, 2008).

For implementing the strategy at a societal level, there is a need for an adequate governance system, as sustainability challenges are complex and uncertain. Adaptive governance addresses this need by introducing a flexible and iterative testing process to implement the respective strategy (Chaffin et al., 2014). Adaptative governance forms do not aim to replace traditional planning processes but to provide new approaches that provide greater institutional and procedure flexibility and more rapid testing solutions.

By integrating these methods, we can confidently foster innovation, teamwork, and education among all parties involved, ultimately resulting in the establishment of more sustainable communities.

2.1 Importance of Experimentation

Experimentation plays a crucial role in transition management as it provides valuable insights into the practical application of different interventions and their scalability and replicability in diverse contexts (Bulkeley, 2013). By conducting experiments, various interventions' practicality, efficiency, and social approval can be assessed. Potential obstacles and opportunities to implement sustainable transitions can be identified in a participatory manner. This approach also helps to address uncertainties and trade-offs, leading to

the development of adaptive strategies to respond to unexpected outcomes and changing circumstances.

In addition, experimentation can promote social learning and collaboration between individuals involved in sustainability efforts. This requires engaging with various perspectives and building trust and a common understanding of the challenges and solutions (Sengers et al., 2019).

When working towards sustainability transitions, experimentation means putting new practices, technologies, policies, and governing methods into action to encourage sustainable practices and lifestyles.

The concept of "niches" introduces some rules to the testing process. Niches can be defined as protected spaces or processes where innovation occurs without being influenced by mainstream trends (Markard et al., 2012). They can also act as a source of inspiration and motivation for actors to act and contribute to the sustainability transition. In other words, niches are places where testing or experimentation occurs.

Encouraging the participation of diverse groups of individuals and organisations in the process of experimentation can prove to be highly beneficial for transition management. By involving local communities in decision-making, this approach can help to foster a sense of empowerment and create a more democratic system. Ultimately, this can lead to socially just and inclusive outcomes, benefiting everyone involved.

2.2 Experimentation in an Urban Context

Urban areas play a crucial role in sustainable development due to their significant impact on environmental, social, and economic aspects. Urban areas have a considerable ecological footprint, consuming resources and generating significant amounts of waste and emissions. However, they also offer opportunities for sustainable resource management, energy efficiency, and renewable energy adoption. Urban planning and design strategies can contribute to mitigating climate change, preserving biodiversity, and promoting sustainable land use (UN-Habitat, 2016).

In the field of urban studies, experimentation can generate new ideas and perspectives within a specific location (Karvonen and van Heur, 2014). This involves conducting experiments in the urban environment at different levels aimed at addressing current challenges by promoting innovation through inclusive and practical approaches. Despite the challenges that come with urban areas, these experiments encourage social learning and contribute towards a more sustainable future (Sengers et al., 2016).

The process of experimentation involves several stages and is not a

straightforward path. It begins with small-scale innovation and eventually influences larger socio-technical systems while also affecting the surrounding environment (as shown in Figure 2).

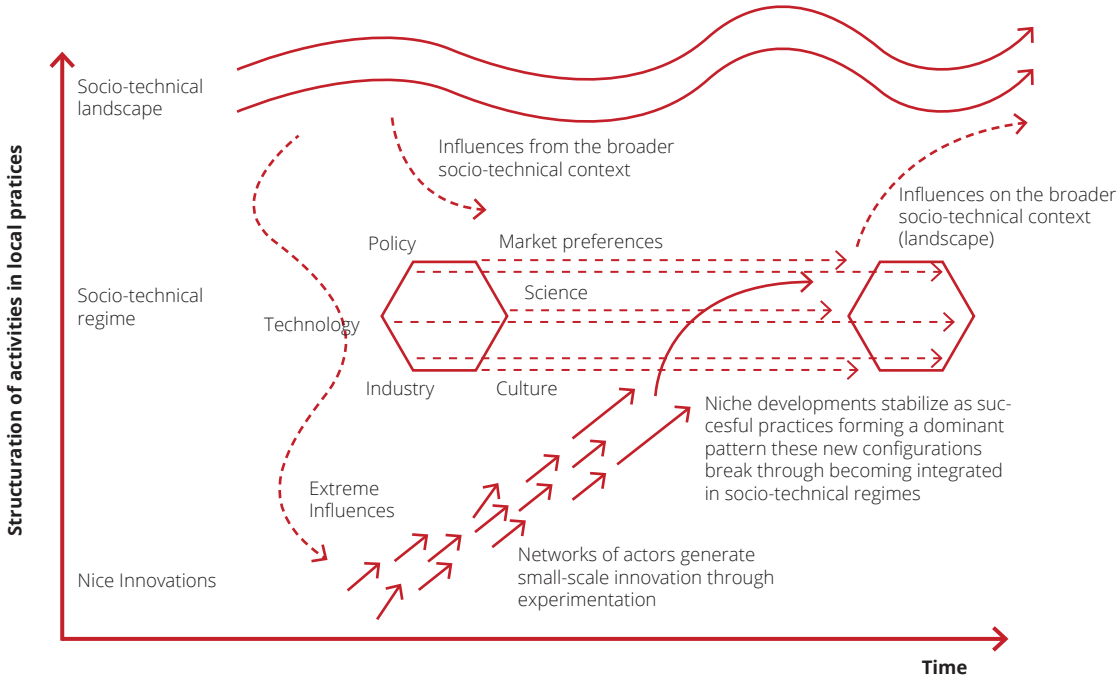

Figure 2: Linking Transition and niche experimentation. Source: Loorbach et al. (2017)

The process of experimentation in urban settings is instrumental in diffusing the innovation to a larger context, laying the groundwork for significant transformative change. Von Wirth et al. (2018) explore three processes: embedding, translation, and scaling. In the embedding phase, the experiment is developed at the local scale, and locally appropriate methods are applied based on the existing local structures. In the translation phase, the second process, the experiment is replicated in another locale than the original. This requires the creation of networks and sharing of knowledge. The final process, scaling, examines how experiments can be scaled up regarding spatiality, content, participation, and the resources required to implement an experiment. Planning can be a collective effort as communication takes a more progressive approach in the postmodern era (Healy, 1992). In this new approach, dialogue is essential for achieving consensus . It involves facilitating communication between different societal groups, focusing on transforming existing structures, whether they are related to material or power dynamics.

In urban settings, it may be beneficial to experiment with new approaches. Local governments can play a larger role in addressing important challenges like mitigating climate change and addressing social problems like segregation (Mc Guirk et al., 2014). Urban experimentation often occurs in designated spaces of innovation known as urban laboratories (Marvin and Silver, 2016).

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3. URBAN LIVING LABS

3.1 Defining Urban Living Labs

The increasing number of institutions that call themselves a Lab or Urban Lab shows a high interest in this concept from universities, science parks, and local governments. Urban Labs is an overarching umbrella term for platforms that provide the opportunity to address urban complexity by promoting elements of experimentation, participation, and collaboration (Scholl et al., 2017).

Urban Labs encompass various forms of urban experimentation that fall under the categorisation of a "Lab", as seen in Figure 1. A plethora of close terms exist, such as "urban lab", "field lab", "testing ground", "hatchery", "incubator", "testbed", "city laboratory" (Steen & van Bueren, 2017), "urban transition lab" (Nevens et al., 2013), "policy labs", "open innovation" labs, "city labs", "lab-like initiatives", "social innovation labs", "design labs", "innovation labs" (Iliopoulos, 2020; Scholl et al., 2017; Schuurman et al., 2013). These typologies of labs demonstrate similarities but might differ at the core of their scope and actions. The confusion stems from the coexistence of multiple terms, having close meanings yet dissimilar characteristics or loosely defined.

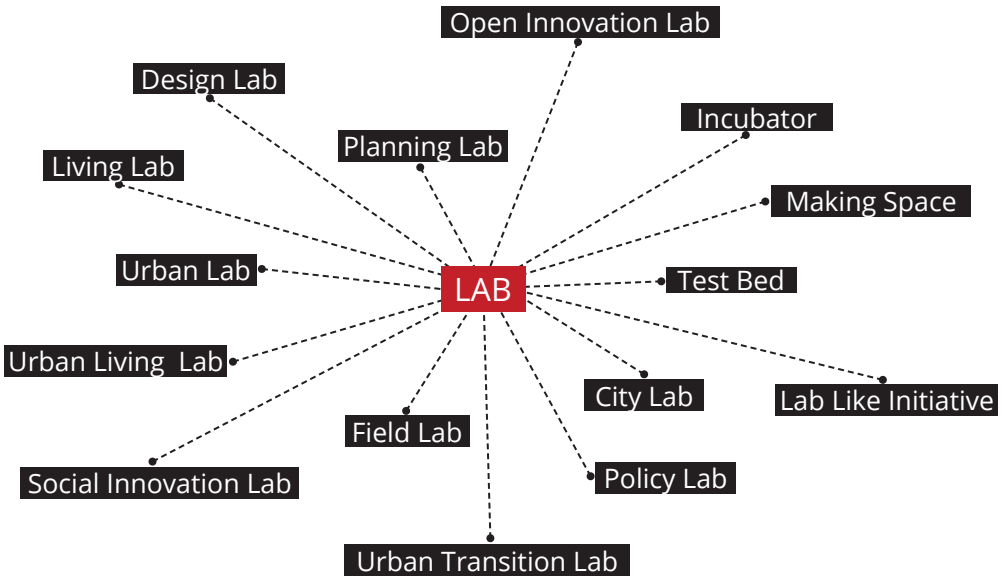


Figure 3: The plurality of lab-like concepts (Source: Own Design)

To gain a comprehensive understanding of Urban Living Labs, it's essential to first delve into the history of Living Labs.

Living labs originated as an approach applied in IT research projects and companies. The Massachusetts Institute of Technology (MIT) is considered a pioneer of living labs with the MIT PlaceLab (1999-2009), where participants were monitored in a 1000-square-foot laboratory to research everyday life

behaviour in home-like environments (European Network of Living Labs, 2019; Leminen et al., 2020). The concept was then driven by IT projects in which companies connect with customers to integrate users' feedback from project inception to design better products. An example is the NokiaSpacelab in the early 2000s, looking at improving the efficiency of mobile devices (European Network of Living Labs, 2019; Leminen et al., 2020).

In an attempt to clarify the concept, the European Network of Living Labs (ENOLL) define 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", focusing on "co-creation, rapid prototyping & testing and scaling-up innovations & businesses, providing (different types of) joint-value to the involved stakeholders" and acting as "intermediaries/orchestrators among citizens, research organisations, companies and government agencies/levels" (ENOLL, 2013; parts in grey underlined as our own addition).

3.1.1 What is the specificity of Urban Living Labs?

Urban Living Labs are a typology of Living Labs, focusing on the urban fabric, territory, and its needs for transitioning into a more sustainable regime. Compared to Living Labs, Urban Living Labs add two further characteristics: on the one hand, a territorial focus and, on the other hand, a goal to identify solutions to sustainability issues concentrated in cities (Chronéer et al., 2019; Steen & van Bueren, 2017). This guide focuses on Urban Living Labs.

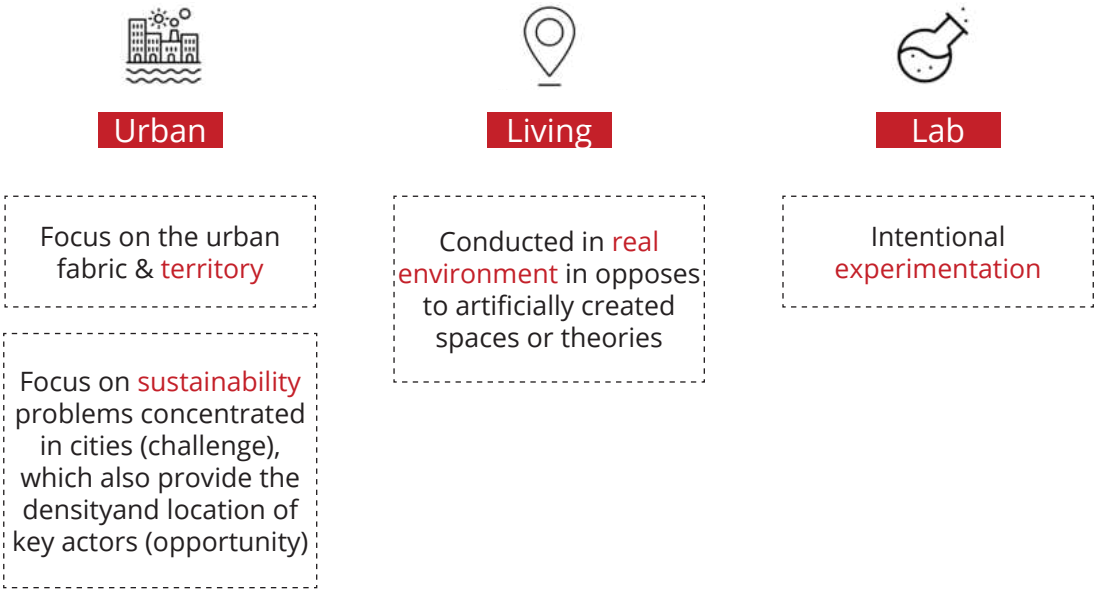


Figure 4: From Living Lab to Urban Living Labs (authors, based on Alexandrakis, 2021)

As listed in Annex I, there are multiple understandings of the Urban Living Labs concept (Steen & van Bueren, 2017; Voytenko et al., 2016). This variety mirrors the diversity of experimental projects, their goals, or the constellations of actors adapted to the local context. However, the lack of uniformity can create complexity in understanding the concept of Urban Living Labs, why and how they should be applied, and create risks of limited impact and "lab-washing". As Urban Living Labs are becoming increasingly used, there is a need for urban practitioners to become more familiar with the concept, its potential and limitations to steer urban change. Consequently, there has been an effort among academics to develop a definition and identify common characteristics to recognise diversity while limiting the risks of confusion (e.g., Chronéer et al., 2019).

In this guide, we use the definition from McCormick & Hartmann (2017) as its identification of two core elements corresponds to most of the definitions of Urban Living Labs (Annex I):

> "Urban Living Labs can be considered both as an arena (geographically or institutionally bounded spaces) and as an approach for intentional, collaborative experimentation of researchers, citizens, companies and local governments."

This definition includes two elements commonly found in various definitions:

- The term arena addresses the first core characteristic that Urban Living Labs are a bounded space, either at a geographical scale (e.g., a household, a university campus or an entire city) or at an institutional scale (e.g. involving key actors).

- The intentional experiments for socio-technical innovation represent a complementary approach to formal planning. Experimentation is critical for testing innovation, co-created at all project stages, allowing feedback and iterations. Participation is critical to enable sustainability transitions that are commonly disputed, break silos, and mitigate fragmentation of responsibilities. To that aim, Urban Living Labs involve participation, typically involving four groups aligned with the quadruple helix model: local governments, citizens or users, knowledge actors, and companies.

3.2 The Key Principles of Urban Living Labs

This definition of Urban Living Labs is operationalised by five key characteristics as identified by the seminal research by Voytenko et al., 2016: geographical

embeddedness, experimentation and learning, participation and user involvement, leadership and ownership, and evaluation and refinement.

Figure 5: Core Principles of Urban Living Labs (authors, based on Voytenko et al., 2016)

Table 1 mutualises theoretical input about these five characteristics and practical implementation and recommendations from the ULLC's experience.

Table 1: Explanation of ULL characteristics

Characteristics	Explanation in the Context of an Urban Living Lab
Geographical embeddedness	Urban Living Labs are in a geographical area: "a real urban context where the process in focus is taking place" (Voytenko et al., 2016) or "real-life use context of the innovation" (Steen & van Bueren, 2017). Various configurations at different geographical scales can be envisaged depending on the project, for instance, from the smallest to the largest: a site such as a building or a road, a neighbourhood or distribution, a city, an agglomeration, an urban area, or a region. This geographical scale should be clearly defined and manageable. Various opinions exist on whether Urban Living Labs should always include physical environments or allow virtual platforms (Friedrich et al., 2013; Leminen, 2015; Westerlund & Leminen, 2011). Voytenko et al., 2016 consider that the use of online tools is possible but that Urban Living Labs should not be predominantly virtual. Steen & van Bueren, 2017 indicate that, most importantly, the product tested within the Urban Living Labs is deployed in a real-life use context; virtual platforms may be adapted to specific Urban Living Labs, e.g., focusing on digitalisation. However, Urban Living Labs will mostly happen in materialised physical environments. Examples: a building, a street, a neighbourhood, a city

Characteristics	Explanation in the Context of an Urban Living Lab
Experimentation and learning	Learning and experimenting lie at the core of Urban Living Labs, which prioritise user-centred testing of innovation, such as new products, services, technologies, applications, processes, and policies in real-world conditions (Voytenko et al., 2016). As Urban Living Labs are about co-creating and testing innovation which is by nature new, they typically dedicate substantial time and resources to capacity building and peer learning first to equip stakeholders with the necessary knowledge to co-design the innovation. This paves the way for the co-production of knowledge and ideas, a crucial component of Urban Living Labs, where participants learn about innovation, exchange knowledge, and jointly identify solutions to existing problems. Remarkably, Urban Living Labs enable testing the innovation(s) under consideration. User experimentation is seen as necessary and beneficial for a couple of reasons. First, testing enables users to get familiar with new solutions they are not yet acquainted with, which can help break routines and enable behavioural change. This may trigger the wider sustainability changes targeted. In addition, testing also allows for assessing the relevance and applicability of the innovation in the local context, which opens the door to potential new findings from users. Feedback is critical in Urban Living Lab, as it enables possible iteration of the tested product, idea, or policy to make it fit the local context. This increases the chances that the innovation will be successfully endorsed and implemented. Examples: testing a specific technique of sustainable construction; testing innovative vehicles such as electric vehicles; testing new mobility behaviours such as incentivised or gamified use of public transport, walking, and cycling; testing nature-based solutions adapted to the local context; etc.
	Urban Living Labs are based on the participation of relevant groups coming from various backgrounds and with complementary expertise. Such participants typically include the users or the product or citizens; private actors (at different scales depending on the project typology, from local to international), public entities (e.g., municipalities, relevant government authorities), and knowledge institutes. Critically, co-creation from participating entities should take place at all stages of the Urban Living Lab implementation (Voytenko et al., 2016), namely steps of user need assessment, objectives and long-term direction, planning and implementation, testing, evaluation, scaling-up and replication. In addition, participants should retain decision-power during

Characteristics	Explanation in the Context of an Urban Living Lab
Participation and end-user involvement	the course of the project, e.g., not only at inception or co-design stage (Steen & van Bueren, 2017). Although real co-creation is critical, the analysis of real-world examples shows that it is often missing from projects identifying themselves as Urban Living Labs (ibid). The various stakeholder groups involved in the Urban Living Labs come from different backgrounds; they have different expertise, power, and resources; it is also likely that they will have different ways to express themselves. "Safe spaces" or creative methods are often needed to allow co-design from all participating partners, for instance, for citizens or users, especially in the case of vulnerable groups in the Global South. Exploring differentiated and innovative methods for participation, making it sector and place-specific, can positively influence the outcomes of the Urban Living Lab by enabling real participation beyond mere consultation (Wolff et al., 2022). Examples of activities: idea workshops, community mapping, mind mapping, transect walks, focus group discussion, design workshops, voting/poll, interviews, surveys, public debate, participatory rural appraisal, community leaders meeting, gamified participation, use of GPS or other GPS tracking device, e.g., mobile air quality sensors etc.
Leadership and ownership	Urban Living Labs enable cooperation between different groups of participants involved in urban sustainability, providing an approach aiming to overcome sectoral fragmentation and work in silos. However, a potential risk is a decreased engagement of participants to take responsibility, as the lab involves multiple actors. Therefore, the identification of a clear leader or owner is critical to mitigating this risk (Voytenko et al., 2016), for instance, via a so-called "local champion" carrying the project and able to address potential challenges emerging. In addition, a central transversal coordination and management role needs to be allocated. This coordinator should be careful not to give the impression that it controls the lab and preserves the decision-making power and co-design principle of participants throughout the process. Sub-coordination roles can be allocated to thematic activities, such as data collection or impact assessment, capacity-building, policy and funding, support to local innovators if relevant to the project, etc. Leadership needs to be well-balanced with participation.

Characteristics	Explanation in the Context of an Urban Living Lab
Evaluation and refinement	Evaluation is essential in Urban Living Labs, as it enables learning and iteration of the product. Despite being central, the assessment of applied Urban Living Lab examples reveal that evaluation and refinement are often given lesser attention than other principles of experimental and participation (Voytenko et al., 2016; Mahmoud et al., 2021). Specific care has, therefore, to be given to this principle, including the planning of an evaluation and refinement stage and the allocation of sufficient time. It is critical to understand that in Urban Living Labs, the iteration of the product is not a sign of failure of the initial concept but rather of adaptation to the local context and a better alignment with the needs of local users. Urban Living Labs not only aim to experiment with products in the local setting but also to produce knowledge on learning, which then enables to diffuse the innovation (Evans & Karvonen, 2011; Steen & van Bueren, 2017). The question of the broader systemic change is critical within Urban Living Labs. Typically, impacts are enabled through a double-edge approach of scaling up the tested pilot (for instance, increasing fleet sizes in a mobility project, enlarging the perimeter for public spaces, etc.) and replicating for further socio-spatial contexts (von Wirth et al., 2019). Examples of iteration: adaptation of a prototype vehicle or housing. Examples of the intentionally targeted impact of successful components: scaling up from a few vehicles to a larger fleet, the extension of the project's geographical area, replication to other areas of the pilot city or other cities in the same country or different countries.

3.3 Expected Benefits of Urban Living Labs

Recognizing these five fundamental characteristics or principles enables us to uncover the anticipated advantages of Urban Living Labs. Drawing from the insights of Urban Living Lab experiences, Figure 6 illustrates how ULL can effectively surmount the challenges in achieving sustainability within development projects. Additionally, it aids in obtaining essential benefits by leveraging these principles.

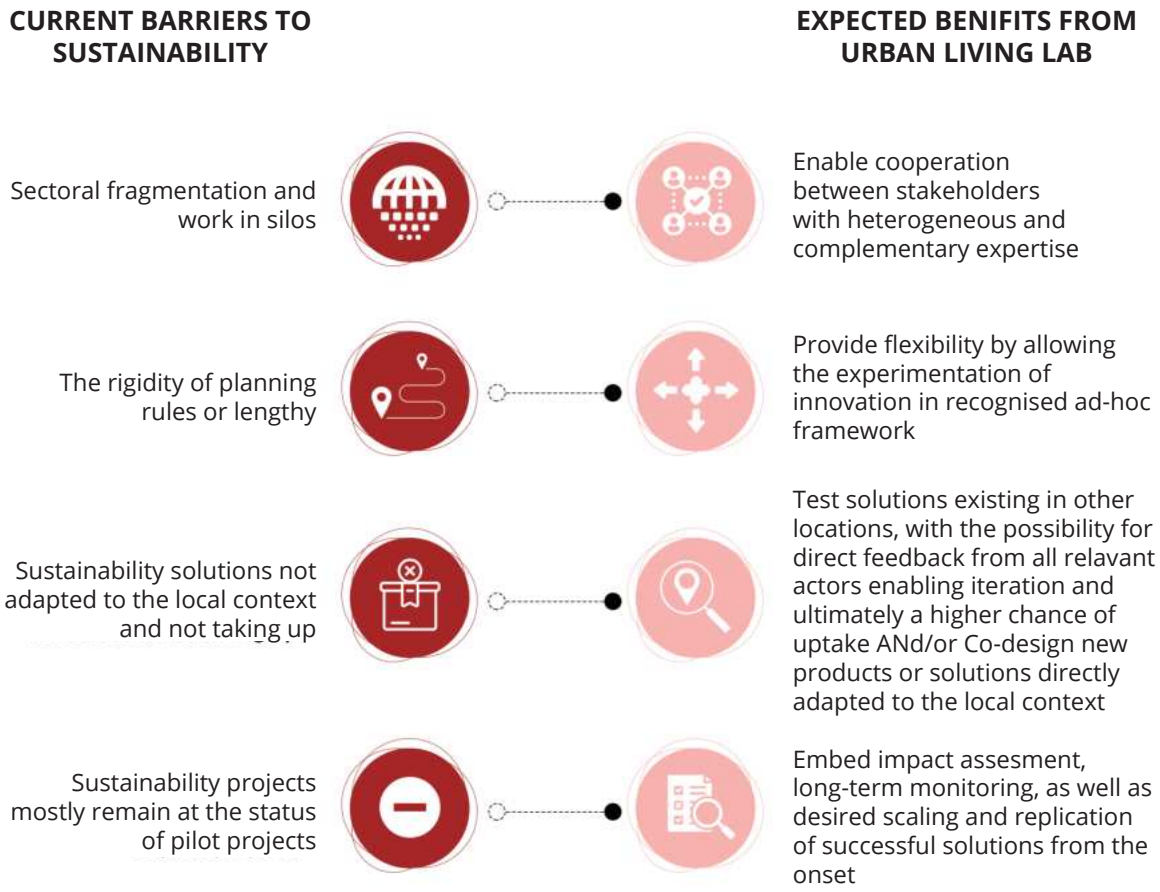


Figure 6: Expected benefits from Urban Living Labs (own design)

3.4 Typologies of Urban Living Labs

Urban Living Labs have been employed across a wide array of projects, from buildings to green space, nature-based solutions, transport, energy systems, local food, and digitalisation to sustainable forms of consumption. This diversity is intrinsic to Urban Living Labs as they have "different goals, they are initiated by various actors, and they form different types of partnerships" (Mahmoud et al., 2021).

This diversity is sensible, as the characteristics of each Urban Living Lab will be designed based on the specific local context and needs. What is essential is that Urban Living Labs include the five building blocks of the approach presented in section 3.2.

Urban Living Labs will vary along the following key aspects (ULLC's own classification):

- **Goal:** Some Urban Living Labs are focused on fulfilling the needs of users or solving identified problems in a controlled setting (e.g. which nature-based solutions are adapted in a given environment), while other Urban Living Labs are more open as they emerge without specific, pre-defined, innovation product or service in mind.

  Examples of problem-solving Urban Living Labs: SOLUTIONSplus, Cities CHALLENGE, Urban Pathways, etc.

  Examples of open Urban Living Labs: Transformative Urban Coalitions, focusing on the introduction and test of new models of coalition building and governance

- **Topics:** Urban Living Labs cover a large variety of sustainability topics that are key for cities, such as nature-based solutions, sustainable housing, public spaces, circular economy, or sector-specific topics often related to urban basic services (e.g. mobility, energy, housing, waste, water, sanitation).

  - Examples related to housing: Concept House Village Lab on sustainable housing and building retrofit (Rotterdam), Malmö Innovation Platform on the renovation of housing for socio-economic development (Malmö).

  - Examples related to nature-based solutions: Clever Cities (Quito) and UNaLab (Tampere, Eindhoven, Genoa).

  - Examples related to urban mobility: TRANS-FORM on the planning of efficient, reliable and robust transport systems (Lausanne, The Hague, Blekinge); SOLUTIONSplus (Quito, Montevideo, Hamburg, Madrid, Kigali, Dar es Salaam, Pasig, Kathmandu, Hanoi, Nanjing).

  - Examples related to energy: Smart Energy Solutions for Africa-SESA (Kisumu, Homa Bay).

  - Examples related to stormwater management: Green Blue Cities (Kiruna, Zwolle).

  - Examples related to food or urban agriculture: CITYFOOD on the introduction of aqua-agriculture systems in cities (São Paulo, Berlin, Grimstad, Arendal), Moveable NEXUS-M-NEX on urban agriculture (Belfast, Doha, Detroit, Tokyo-Yokohama, Amsterdam, Sydney).

  - Examples related to waste: WASTE FEW ULL on the reduction of resource inefficiencies in the urban food-energy-water nexus (Cape Town, Rotterdam, Campinas, Bristol).

  - Examples related to a circular economy (CE): Blue City Lab 010 on circular

economy entrepreneurship (Rotterdam).

    - Other topics: Sharing Cities on the application of digitalisation in urban mobility, building energy efficiency, and reduction of carbon emissions (London, Lisbon, Milan); Stapeln on sustainable consumption and production; CASUAL on sustainable living and consumption in cities (Stockholm, Vienna); SubUrbanLab on the modernisation of suburbs (Alby/Botkyrka, Peltosaari/ Riihimäki); APRILab on planning approaches on uncertainty and economic instability in urban development (Istanbul, Amsterdam, Helsinki, Copenhagen, and Aalborg).

- **Scope:** some Urban Living Labs focus on one specific topic, while others merge different topics, for instance, to enable sector coupling and circularity. Other Urban Living Labs look at a tool for use across different sectors (e.g. Sharing Cities, use of digital technology for various uses, including mobility and buildings).

    - Examples of coupled Urban Livings Labs: UNEX on the Sustainable Urban Food-Energy-Water Nexus (Berlin, Bristol, Doha, Vienna); EcoZone, Urban Pathways looking at joining introduction of measures improving public space, urban mobility, and waste management (Belo Horizonte); ENLARGE on the integration and mobilisation of food, water and energy resources (Amsterdam, Miami, Marseille).

- **Context:** McCormick & Hartmann (2017) distinguish different contexts in implementing an Urban Living Lab along with their key leaders :

    - Strategic: A government or large private actors engage in an entire city via multiple projects under one vision.

    - Civic: Led by participation and actors such as universities, municipalities, and urban developers, dedicate their efforts to sustainable/economic urban development via a single project or district focus and have co-funding allocated.

    - Grassroots: Civil society and/or non-profit participation via micro or standalone projects, typically characterised by small budgets.

The Urban Living Labs mentioned above are only a glimpse of the remarkable variety of existing Urban Living Labs. More examples can be found on the website of the JPI Urban Europe, created in 2010 with the aim of addressing global urban challenges and developing a European research and innovation hub on urban matters (https://jpi-urbaneurope.eu/).

3.5 Case studies of Urban Living Labs

Case studies below, implemented by the ULLC, aim to illustrate the five principles presented in Section 3.2.

Case study: SOLUTIONSplus, pilot Dar es Salaam

- *Geographical embeddedness:* Dar es Salaam pilot as part of the global project, implemented in 10 cities and 11 replication countries.

- *Experimentation and learning:* the topic of low-carbon mobility; innovation tested: development of locally adapted electric vehicle prototypes, business models and policies. Multiple capacity-building activities targeting various scales (global, regional, city) under various modalities (online, in-person); peer-to-peer exchange.

- *Participation and end-user involvement:* in Dar es Salaam, 11 organisations representing local public institutions (Dar es Salaam Rapid Transit Agency), research and knowledge partners (Dar es Salaam Institute of Technology, German Aerospace DLR, Wuppertal Institute, TUB Berlin, UEMI, ITDP Africa), industry partners (IDIADA, FIER Automotive, IDIADA, PluService), together with citizens (transport providers, i.e. drivers of three-wheeled vehicles and cycling cooperative, passengers).

  Partners from the Dar es Salaam Lab is supported by 46 consortium partners providing cross-cutting support to cities, e.g., for capacity-building or policy advice (e.g., UN-Habitat, UN Environment, CODATU, POLIS).

- *Leadership and ownership:* coordination at the global level through UEMI; lead at the local level through DART; partners leading in thematic subgroups (e.g., data collection, capacity building, policy, etc.)

- *Evaluation and refinement:* identification of the needs and preferences of transport operators (drivers), consequently adjusting the vehicle technical specifications. Scaling-up and replication is ensured via a programme to scale-up e-feeder services to the BRT; replication of the three-wheeler component to a rural context in Kenya

- Duration: four years

- Budget: financial support to local innovators of approximately 330.000 euros; circa 20 million euros at consortium level for all ten pilot cities, 11 replication countries, and 46 partners.

Case study: Urban Pathways, pilot Belo Horizonte

- *Geographical embeddedness:* three neighbourhoods in Belo Horizonte, Brazil.

- *Experimentation and learning:* topics of sustainable, inclusive, and liveable neighbourhoods, reclaiming public space; tested innovation: testing the concept of EcoZones coupling sustainability mobility, public space, waste management and nature-based solutions.

- *Participation and end-user involvement:* 8 organisations for the institutional support (municipality, public transport & transit company, waste management department) and for international and knowledge support (Wuppertal Institute, UN-Habitat, WRI Brazil, TUMI, SDSN Youth) and a wide range of community (school, neighbours, local NGOs, volunteers) completed by business owners and universities.

- *Leadership and ownership:* local champion (Eveline Prado Trevisan,

Sustainability & Environment Coordinator at the public transport company BHTrans)

- Evaluation and refinement: solid and transparent impact assessment (surveys, vehicle and pedestrians counts, women safety audit, air quality and noise monitoring) to document the impact. The project was scaled as the pilots were transformed in permanent zones and followed by several replication cases in the city based on a political decision to implement at least one in each district as well as replicated in two areas in Quito, Ecuador.

- Budget: approximately 20,000 euros

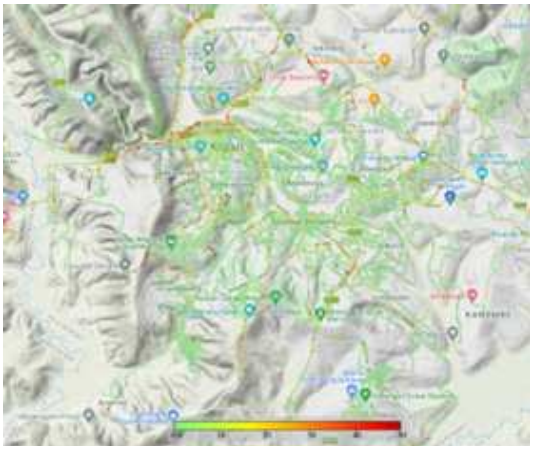
- Duration: less than a year

Case study: Urban Pathways, Air Quality, pilot Kigali

- Geographical embeddedness: Kigali, Rwanda, Ampersand's office and swapping station as a deployment base.

- Experimentation and learning: the topic of air quality; innovation tested: testing the added value of mobile, low-cost air sensors to map air pollution hotspots throughout the city, in complementarity to static stations, and with moto-taxis instead of usual bicycles. Capacity-building activities on air quality modelling and monitoring.

- Participation and end-user involvement: 8 partner organisations representing knowledge institutions (the University of Rwanda, University of Helsinki, open-Seneca from the University of Cambridge), private sector (Ampersand), public authorities (City of Kigali), users (motorcycle-taxi drivers, cyclists), knowledge and coordination organisations (UN-Habitat, Urban Electric Mobility Initiative-UEMI); feedback from drivers on contexts of hotspots observed.



- Leadership and ownership: coordination through UEMI, thematic sub-leadership on scientific air quality monitoring and capacity building.

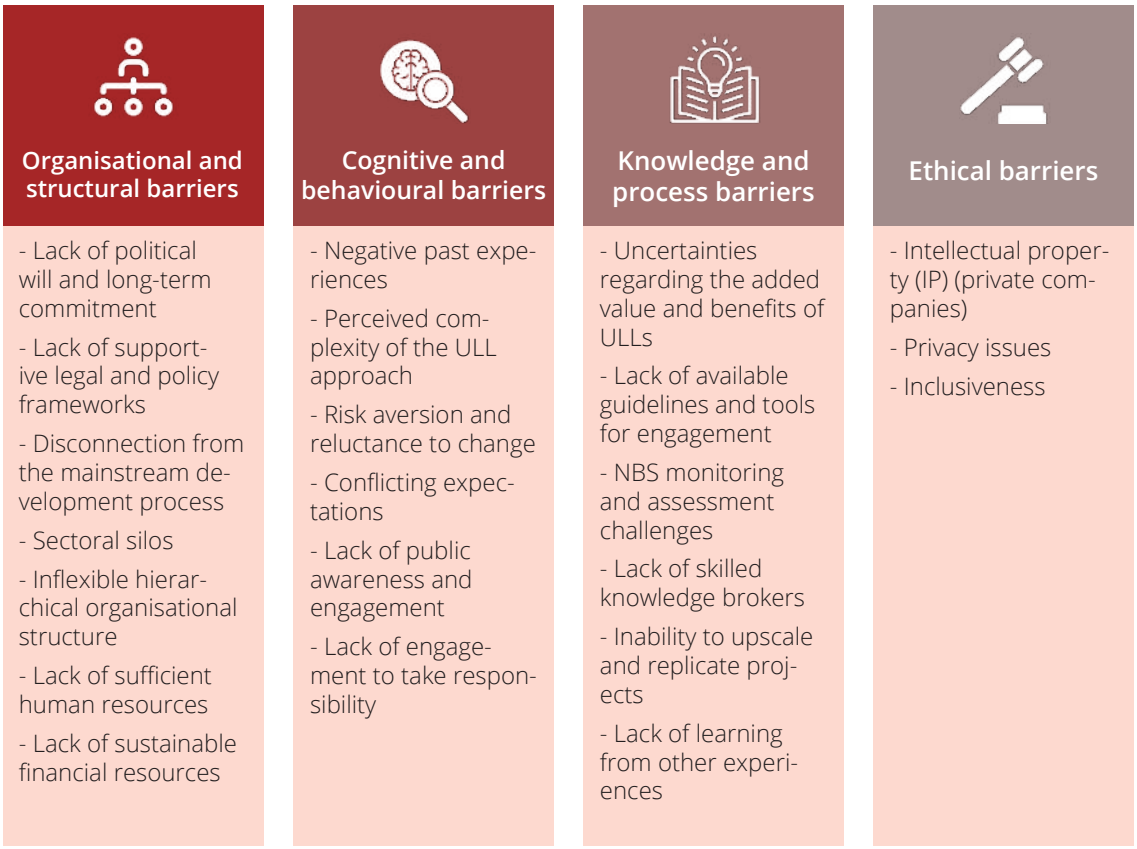
- Evaluation and refinement: minor adjustment of the device and adjustment on the vehicle; confirmation of the interest in using a taxi fleet to extensively map the city and of the complementarity of mobile sensors to static stations. With regards to scaling up and replication, sensors in the ownership of the University of Rwanda for further use and update of the hotspot map; the project in Kigali was already a replication from a successful pilot in Nairobi, Kenya; simultaneous deployment of air quality low-cost mobile sensors in Kathmandu, Nepal and Quito, Ecuador.

- Duration: less than a year

- Budget: approximatively 25.000 for three cities

3.6 Challenges in Urban Living Labs

Although prior studies largely agree on the importance of close collaboration and the benefits it brings to different participants, they also stress challenges related to the methods and concepts of living labs. These challenges are diverse and may be associated with the type of Urban Living Lab and the context in which it operates.



In the above figure Sarabi et al., 2021 provide a comprehensive overview of challenges structured around four key dimensions: organisation and structural barriers, cognitive and behaviour barriers, knowledge and process barriers, and ethical barriers.

Hossain 2019 adopts another classification of barriers centred around aspects of (i) temporality, (ii) unforeseen outcomes, and (iii) efficiency (among others). Temporality can have a beneficial effect on Urban Living Labs. One reason is that it is easier to convince decision-makers about a temporary intervention than a permanent one. Once implemented and proven successful, it is easier to persuade stakeholders to maintain the measure.

On the other hand, Mahmoud et al. (2021) also raise the concern that often, insufficient time is planned in Urban Living Lab to properly evaluate the impacts of the pilots over a sufficient time, which is a challenge for the long-term sustainability of the project.

In any project, unforeseen outcomes and unintended consequences can occur. Generally, there is no one-size-fits-all solution to prevent this problem. General contingency plans, including contingency time and funding, can help alleviate the consequences. When and where most benefits can be obtained from Living Labs (Hossain, 2019) represents another challenge compared to other innovation approaches.

Most Urban Living Labs are implemented, and a large share of experience is in the global North, particularly in Europe and research from the Global South is underrepresented.

Another challenge is “lab-washing”. Steen & van Bueren (2017) found that most of the 90 projects in Amsterdam labelled as “Urban Living Labs” do not include one or more of the defining elements of Living Labs. Especially co-creation (only 12 projects did) and development. Several of these projects are incorrectly labelled as living labs despite not having regular stakeholder engagements, which are mandatory for an Urban Living Lab.

Other challenges include governance, the recruitment of user group(s), and the scalability of their innovation activities.

4. STAKEHOLDER ENGAGEMENT

Co-creation is an inherent aspect of all kinds of Urban Living Labs. A crucial factor for an effective co-creation process and the very definition of urban living labs is the continuous involvement of various stakeholders. The extent to which the participants from various groups are involved in the Urban Living Labs can determine the success or failure of a Lab. Even if a project produces a solution that addresses the issue, from the Urban Living Labs definition sense, such a project may not be classified as an Urban Living Lab when effective stakeholder involvement is absent (Steen & van Bueren, 2017).

Urban Living Labs are experimental spaces where diverse participants collaborate to develop, test, and validate innovative solutions for sustainable urban development. By integrating participatory approaches and inclusive governance, incorporating co-design, co-production, and co-development, and involving epistemic communities (expert groups) and businesses and entrepreneur communities, these labs create societal consensus for sustainable urban development. This chapter discusses the role of these elements in Urban Living Labs and explores their potential for promoting sustainable urban development.

Who are the stakeholders?

When it comes to the involvement of various stakeholders in Urban Living Labs, most literature identifies four key actors , namely, civil society, private actors, public actors and academia. This has also been referred to as the quadruple helix model (Nguyen & Marques 2022). The key stakeholders are active contributors to the co-creation, co-development and innovation process. For Urban Living Labs to be effective, they should recognise that these key stakeholders have different expertise and particular roles in the process of innovation (Iyer-Raniga & Junior, 2020). The following section explores the roles of each key stakeholder and the challenges they face in participating in Urban Living Labs.

4.1 Public actors

As Urban Living Labs are embedded in "a real urban context where the process in focus is taking place" (Voytenko et al., 2016), they are also embedded in existing institutional contexts and governance frameworks on local government, provincial/sub-national and national levels. As cities can be innovative sites for climate politics and for sustainability and environmental transitions (Kronsell & Mukhtar-Landgren, 2018), local governments play a critical role, as the experimentation process in Urban Living Labs requires many complex bureaucratic and legal processes. Local governments possess authoritative power that can impact policies and regulations. Their formal decision-making power can also assist in circumventing regulations and acts (Steen & van Bueren, 2017).

Examples: local governments, municipalities, state, provincial or sub-national ministries and agencies, national ministries, public agencies, parastatals, energy providers, and transport providers.

4.2 Civil society, community, and end-users

The participation of civil society and communities as users is crucial in ensuring that Urban Living Labs are more contextually relevant, effective, and sustainable. Civil society assists in co-designing and co-developing innovative solutions and testing new ways of addressing sustainability challenges (Bulkeley et al. 2016, Franz 2015, Menny et al. 2017). Actively involving civil society at the early stages of the Urban Living Lab is vital in ensuring that they "shape the process rather than just respond to it" (Bergvall-Kåreborn and Ståhlbröst 2009, JPI Urban Europe 2013, Menny et al. 2017). By sharing specific knowledge based on their needs, preferences and experiences, civil society is provided with the chance to shape their own environment and be involved in the process of developing their own cities.

Examples: residents as individuals, residents as a group (neighbourhood association, schools and individuals involved in schools, local NGO, religious group in some locations etc.), users of a service provided locally (e.g., transport mode), providers of a service provided locally (e.g., transport operators, waste collectors)

4.3 Academia

Urban Living Labs play a pivotal role in integrating educational experiences with scientific and technical possibilities to achieve positive outcomes in real-life contexts (Iyer-Raniga & Junior, 2020). Academic institutions, particularly universities, play a crucial role in imparting the necessary skills and knowledge to the next generation, enabling them to tackle sustainability challenges and seize opportunities through research that promotes sustainable development (ibid). Furthermore, these institutions are responsible for educating future professionals, which places an ethical obligation on them to explore and implement practical solutions for supporting sustainability across various aspects such as research, education and engagement with the broader community in a collaborative and innovative way. Through utilising their own campuses, higher academic institutions can demonstrate and trial sustainability research, generating and disseminating new knowledge effectively (ibid).

Examples: local universities, ideally public, possibly benefitting from the additional and complementary support from peer universities in other locations (other cities in the same country, in other countries)

4.4 Private Actors

Private actors such as non-academic subject-matter experts and corporate institutions play a vital role in Urban Living Labs. Subject-matter experts provide expert knowledge and facilitate the transfer of ideas across different domains (Haas, 1992; Cash et al., 2003). The recipients of this knowledge are all the stakeholders involved in the Urban Living Lab.

Subject-matter experts consist of professionals and experts with shared beliefs and interests. They can inform decision-making and bridge gaps between various stakeholders. By leveraging their expertise, Urban Living Labs can develop evidence-based, robust, and scalable solutions for sustainable urban development.

Corporate institutions such as businesses and entrepreneurs help create societal consensus by promoting cooperation among diverse interest groups and facilitating negotiations between them (Lijphart, 1991; Schmitter, 1974). In the context of Urban Living Labs, they can facilitate dialogue and collaboration among participants, developing shared goals, mutual understanding, and trust. This consensus-building process is critical for the successful implementation and long-term sustainability of urban development solutions.

Examples: local businesses (e.g., shop owners, construction and architecture companies, transport companies, waste collection companies, etc.), completed if needed by companies located elsewhere and for peer exchanges (e.g., companies located in the Global North or South countries if bringing a specific type of expertise in the relevant field)

4.5 Participatory methods to engage with stakeholders

Participatory approaches and inclusive governance are crucial for fostering collaboration among various groups in Urban Living Labs. Drawing on the literature (Arnstein, 1969; Fung & Wright, 2001; Cornwall, 2008). So far, we discussed the role of different stakeholders and their influence on the outcomes of Urban Living Labs. By adopting participatory approaches, labs can ensure that diverse perspectives are considered, leading to more contextually appropriate and inclusive solutions.

Inclusive governance involves transparent decision-making with all relevant groups, emphasizing accountability and continuous engagement. This fosters innovation and sustainable urban solutions when combined with participatory approaches.

A participatory approach involves seeking input from all parties affected by a decision. This ensures all viewpoints are considered. It's commonly used in development projects to involve community members in decision-making

processes, making initiatives more relevant, effective, and sustainable. The level of participation varies depending on the purpose.

Authorities should involve all stakeholders in decision-making, from providing information to actively supporting citizens' initiatives. Higher levels of participation create a sense of ownership and commitment, resulting in a more effective partnership. Various methods can be used to gather input, such as consultation and feedback.

- Disseminating information: Informing the public through media and social media has wide reach but low involvement.

- Surveys: Surveys gather data and opinions from end users for policy and plan drafting, with both qualitative and quantitative questions.

- Public consultations: Decision-makers can improve public feedback by actively seeking input from end users rather than relying solely on civil society organizations during a set timeframe for comments and complaints.

- Community forums: The government holds public meetings to get the public's input on policies and plans. It's more involved than public consultations.

- Focus group meetings: Focus group meetings allow government officials and user groups to discuss policies and plans in a valuable interactive setting. However, these groups may not represent the needs of all end-users.

- Workshops: Workshops educate stakeholders using tools like group activities, audio-visual aids, and case studies to identify priorities, action items, and problems.

While participatory approaches provide a more inclusive approach to decision-making, they can be susceptible to certain barriers:

- Power imbalance: Certain individuals or groups may have more influence in decision-making, resulting in smaller groups being excluded in the process.

- Need for capacity: Stakeholders identified as part of the participatory process may not have the necessary capacity and hence require building such capacity before being part of the process.

- Time and resources: Participatory approaches require significant time and resources to bring together all the stakeholders. This often leads to such consultations being a one-time activity or an exercise that does not include all the stakeholders.

In addition to the above, participatory approaches are commonly applied to address a problem identified or to get public opinion on a solution already available for implementation.

With the rapidly changing technological landscape and the increasing urgency for practical solutions, participatory approaches will need an upgrade. Urban solutions require a more coordinated approach with the involvement of various stakeholders. Replication of solutions implemented elsewhere will need to be adapted for a local context, which will need prior testing of the solutions. The Urban Living Labs approach provides an opportunity to do more with the current participatory approaches. Here are a few reasons why ULLs may be preferred:

- Living labs offer a special opportunity to test and try out new ideas in real-life situations. Researchers, businesses, and citizens can work together within an urban environment to improve and perfect new technologies, products, or services. This practical and hands-on process of experimentation and co-creation can result in speedy innovation and practical outcomes.

- Living labs are designed to create solutions that can be easily scaled up and replicated in other contexts. By involving multiple stakeholders and creating a network of living labs, successful ideas can be shared and adapted to different urban environments. This scalability enables a broader impact and the potential for solutions to be adopted in other cities or regions.

- Living labs require collaboration among researchers, businesses, government agencies, and citizens to create comprehensive solutions for urban challenges. This collaboration improves understanding and promotes innovation by bringing diverse expertise and viewpoints together.

- Using sensors and monitoring systems, living labs collect and analyse data to gain insights and make informed decisions on urban aspects like energy consumption and air quality.

- Living labs help businesses and start-ups test new products and services in cities, promoting entrepreneurship, economic growth, job opportunities, and innovative solutions with commercial potential.

In a living lab, all stakeholders work together to identify an issue, develop a solution through co-creation, and find ways to overcome any barriers.

Although both ULLs and participatory approaches involve collaboration, ULLs require collaboration and co-creation as the main components. In ULLs, co-creation is an iterative process where a solution is tested in a real-world setting.

A comparison of both approaches can be seen in the table below:

Table 2: Comparison of participatory approaches and ULL approach

	Participatory Approach	ULL Approach
Focus on experimentation and real-world testing	Possible with pilot projects but not an iterative process	Co-creation is inherent to ULLs, and it is an iterative and interactive process
Focus of solutions	Higher level focus on social, cultural and environmental dimensions	Local focus on applicable and replicable solutions
Range of stakeholders	It can be implemented with few stakeholders with a mandatory inclusion of the decision-makers	Broader involvement of stakeholders is required for a ULL approach. This includes involving the businesses and local entrepreneurs
Data collection and analytics	Chiefly employ qualitative data collection and prioritise local knowledge	Use complementary innovative methods for data collection and collect quantitative data in addition to qualitative data
Assessing the results	Assessments are done at the end of the project	Assessments are done at the end of a solution development cycle, and due to the iterative nature, the assessments in ULL are iterative

Unsplash

5. SYSTEMATIC APPROACH TO DEVELOPMENT AND CO-CREATION

To effectively integrate the various elements discussed in this chapter, we propose a systematic approach to developing and co-creating Urban Living Labs through the 5 I's Framework: Inform, Inspire, Initiate, Implement, and Impact. This framework provides a structured process for Urban Living Labs, ensuring all aspects are addressed and integrated coherently.

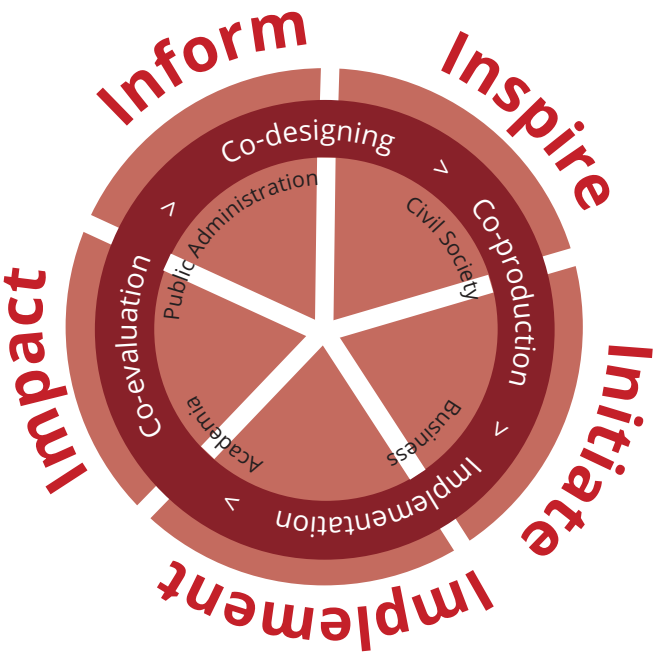


Figure 7: The 5-I framework (authors' work)

5.1 Inform: Capacity Building and Awareness Raising

The first stage of the 5 I's Framework focuses on building participant capacity and raising awareness of the innovation addressed within the Urban Living Lab. It involves various activities such as conducting training workshops and seminars for decision-makers, developing educational materials, and organising public events.

- Conducting training workshops and seminars: Decision-makers are provided with specialised training on participatory approaches, inclusive governance, and collaborative processes. This equips them with the necessary knowledge and skills to effectively engage in the topic addressed in the given Urban Living Lab.

- Developing educational materials and resources: Informational materials and resources are created to educate participants about methodologies and best practices related to the lab's focus. These materials serve as references to help participants understand the concepts, processes, and benefits associated with the topic or approach at stake.

- Organising public events and campaigns: Public events and campaigns are organised to raise awareness among the public about the lab's focus and its potential for addressing urban challenges. These events aim to engage and inform the wider community, fostering a sense of ownership and involvement in sustainable urban development initiatives.

- Raising awareness: The primary goal of this stage is to increase awareness about the importance of sustainable urban development and the role the Urban Living Lab can play in achieving it. By disseminating information through various channels, decision-makers and the public become more informed about the potential of the Urban Living Lab.

5.2 Inspire: Stakeholder Motivation

The second stage of the 5 I's Framework focuses on inspiring and motivating participants by showcasing successful case studies, hosting influential speakers, and providing opportunities for participants to visit peers or places applying a similar innovation. This stage emphasises the value of collaborative approaches.

- Showcasing success stories: Successful case studies from existing Urban Living Labs on a similar innovation are shared to demonstrate the potential of collaborative approaches and of the innovation. These success stories serve as examples to inspire participants.

- Hosting inspirational speakers and thought leaders: Influential speakers and thought leaders are invited to share their insights and experiences regarding the given innovation and the role of Urban Living Labs. Their expertise and perspectives help motivate participants by highlighting the benefits and transformative potential of participating in Urban Living Labs.

- Providing visitation opportunities: Participants are given a chance to visit successful Urban Living Labs on a similar innovation. By observing the outcomes and interacting with stakeholders involved in these Labs, participants can learn from peers, exchange views on targets and brainstorm on similar challenges.

5.3 Initiate: Co-development

The third stage of the 5 I's Framework, known as Initiate, focuses on initiating the co-development process within the Urban Living Lab. It involves organising workshops and public consultations to identify challenges and opportunities and establishing working groups comprising diverse stakeholders to collaboratively develop the Urban Living Labs and design pilot projects to test. The third stage, Initiate, focuses on initiating the co-development process, bringing participants together to jointly identify challenges and opportunities

and develop potential solutions. Activities in this stage may include:

- Organising workshops and charrettes: Workshops and charrettes are conducted to facilitate the identification of the challenges at stake and opportunities. Participants from various backgrounds and expertise come together to brainstorm potential solutions. These collaborative sessions encourage active participation, idea generation, and knowledge sharing among stakeholders.

- Establishing working groups: Working groups are formed, consisting of representatives from diverse stakeholder groups, epistemic communities, and corporatist institutions. The diverse perspectives and expertise within the working groups help ensure a holistic and inclusive approach to the topic of the given lab.

- Designing pilot projects: Pilot projects are developed as a means to test the feasibility and effectiveness of proposed solutions within the Urban Living Lab. These projects serve as small-scale experiments to gather feedback, assess the impact of the proposed solutions, and identify areas for improvement. The iterative nature of pilot projects allows for adjustments and refinements to be made based on real-world implementation and feedback.

5.4 Implement: Co-creation

The fourth stage of the 5 I's Framework, Implement, focuses on the co-creation of the Urban Living Lab, where participants work together to refine, develop, and implement sustainable urban solutions. This stage involves collaboratively designing and implementing the Lab, establishing monitoring and evaluation processes, and providing ongoing support and resources to stakeholders involved in the implementation.

- Collaboratively designing and implementing the Urban Living Lab: In this stage, participants work together to design and implement the Urban Living Lab. The diverse perspectives and expertise of stakeholders are incorporated to ensure a comprehensive and inclusive approach. Collaborative decision-making processes are employed to refine the design, set goals, and develop strategies for implementing sustainable urban solutions.

- Establishing monitoring and evaluation processes: Monitoring and evaluation processes are put in place to track the progress and impact of the Urban Living Lab. These processes help assess the effectiveness of the implemented solutions, identify areas for improvement, and inform ongoing adjustments. Data collection, analysis, and reporting mechanisms are established to gather relevant information and measure the success of the Lab.

- Providing ongoing support and resources: Ongoing support and resources are provided to stakeholders involved in implementing the Urban Living Lab. This includes offering training, capacity-building initiatives, and access to tools and knowledge necessary for success. Continuous engagement and collaboration are fostered to ensure stakeholders have the necessary support to overcome challenges and achieve sustainable urban solutions.

5.5 Impact: Replication and Scaling-Up

The final stage of the 5 I's Framework centres on assessing the impact of the Urban Living Lab and identifying opportunities for replication and scaling up. This stage involves conducting evaluations to measure the impact on urban sustainability and inclusivity, identifying successful initiatives for replication or scaling-up, developing strategies and partnerships for expansion, securing funding and financing solutions, and sharing best practices and case studies to promote the adoption of successful approaches.

- Conducting robust evaluations: Robust evaluations are carried out to assess the impact of the Urban Living Lab on urban sustainability and inclusivity. These evaluations involve measuring the outcomes and effects of the implemented solutions, gathering data, and analysing the results. The findings help determine the effectiveness and success of the Lab and provide insights for future improvements.

- Identifying initiatives for replication or scaling-up: Successful initiatives within the Urban Living Lab that have demonstrated positive impact and potential for replication or scaling-up are identified. These initiatives can serve as models for similar projects in other urban contexts. Identification of such initiatives allows for the transfer of knowledge, strategies, and approaches to address urban challenges in different locations.

- Developing strategies and partnerships: Strategies and partnerships are developed to support the replication or scaling-up of successful initiatives. This involves identifying key stakeholders, forming collaborations, and establishing networks to provide resources, expertise, and support for expansion. The aim is to create a sustainable framework for implementing similar initiatives on a larger scale.

- Securing funding and financing solutions: Adequate funding and financing solutions are identified to support the replication and scaling-up efforts. This may involve seeking public or private funding, exploring grants, partnerships with financial institutions, or developing innovative financing models to ensure the availability of resources required for expansion.

- Sharing best practices and case studies: best practices, lessons learned, and case studies from the Urban Living Lab are shared with a wider audience.

This includes publishing reports, organising conferences or workshops, and utilising online platforms to disseminate knowledge and experiences. By sharing successes and lessons learned, a community of practice is fostered, encouraging the adoption of successful approaches to urban sustainability and inclusivity.

Successful Urban Living Labs often have the potential to be scaled up and replicated in other contexts. To support the scaling up and out of the Urban Living Lab solutions, practitioners should:

- Develop Scalable and Adaptable Solutions: Design the Urban Living Lab with scalability and adaptability in mind, ensuring that they can be easily adjusted to fit different contexts and situations.

- Establish Partnerships for Scaling: Build partnerships with other Urban Living Labs, municipalities, and organisations that can support the scaling up and out of successful initiatives. These partnerships can provide valuable resources, knowledge, and expertise to help adapt and implement solutions in new contexts.

- Document and Share Experiences: Document the experiences and lessons learned from Urban Living Labs, making this information available to others interested in replicating or scaling the initiatives. This can include developing case studies, guidelines, or toolkits to facilitate knowledge transfer and best practices.

- Advocate for Policy Change: Work with policymakers and other decision-makers to advocate for policy changes that support the scaling up and out of Urban Living Lab solutions. This may involve promoting the adoption of participatory approaches, inclusive governance, and collaborative processes at larger scales or in other policy domains.

Urban Living Labs can create innovative and sustainable urban solutions by integrating participatory approaches, inclusive governance, co-design, co-production, and co-development, and leveraging the expertise of epistemic communities and corporatist institutions. Implementing robust monitoring, evaluation, and learning processes and focusing on scaling up and out will ensure these initiatives' long-term success and impact, ultimately contributing to more sustainable and inclusive urban environments.

Implementing the 5 Is framework in a project context is depicted in the conceptual framework of an EU-funded project in Figure 7. This project shows that the 5-Is framework is not a theoretical construct but a practically implementable process, even in a project with many stakeholders, including cities, academia, businesses, and entrepreneurs.

Figure 8: Conceptual framework of the SOLUTIONSplus project funded by the EU (authors' work)

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6. URBAN LIVING LABS IN GERMAN DEVELOPMENT COOPERATION

Urban Living Lab approaches have been increasingly applied in various geographical and thematic areas in German Development Cooperation programmes. Most of the time, these programmes integrate some elements of the Urban Living Lab approach without necessarily using this exact terminology, e.g., Urban Labs or City Labs.

After sub-section 6.1. presenting examples of Urban Living Lab-like initiatives implemented by various actors involved in German Development Cooperation, the remaining sub-sections 6.2. to 6.5. will focus on the GIZ-led City WORKS and Cities CHALLENGE, where desk research and interviews enabled refined assessment of the projects against the approach of Urban Living Labs. These sections will not evaluate Urban Living Lab-like initiatives developed by other actors involved in German Development Cooperation, as the information available on these programmes via desk research does not necessarily guarantee exhaustive and up-to-date analysis, constraining the ability to identify if some typical components of Urban Living Labs may be missing from these initiatives.

6.1 Urban Living Lab-like projects deployed by German Development Cooperation actors

6.1.1 Projects led by the GIZ or with GIZ involvement

Describing Cities CHALLENGE

Cities CHALLENGE is a GIZ internal ideas competition that aims to showcase what safe, inclusive, resilient, sustainable and climate-friendly cities look like on the ground. It was first launched by the GIZ project 'CityRegions 2030' and realised in a second round through Sector Programme Cities and is funded by the German Federal Ministry for Economic Cooperation and Development (GIZ 2021).

The vision for Cities CHALLENGE was to invite urban projects from German development cooperation partner countries to provide ideas for developing climate-friendly solutions for vibrant neighbourhoods that benefit residents and strengthen their resilience together with local partners. The proposed ideas from the partner countries would be tested in Urban Living Labs with the potential for a high level of scalability and replicability. Projects were to be based on various concrete entry points such as a clear reference to climate-friendly and inclusive urban development, improving the living conditions and resilience of the target group and testing of climate-friendly, context-specific building solutions. The variety of entry points aimed to encourage and involve a diverse group of stakeholders. This would establish partnerships with German development actors, which would enable joint action in addressing municipal finance, urban planning and governance challenges. Cities CHALLENGE 2.0 had the following central goals (GIZ 2022):

- Mainstreaming: Increasing the visibility of urban development in German DC.
- Reality-check: incorporating local needs and experiences into effective policy making
- Implementation: Testing new approaches under BMZ guidelines
- Dialogue: Mobilising innovative potential for portfolio development.

Describing City WORKS

Aligning local development measures with global agendas ensures urban sustainability. With the goal of providing countries with the necessary methodological resources to implement global agendas at the local level, GIZ designed the toolbox City WORKS. This toolbox follows a process-oriented approach with 3 phases and 8 steps and offers a range of methodological and technical tools to support the vertical integration of global agendas at the local level (GIZ 2021).

City WORKS emphasizes the significance and impact of global agendas on cities, providing tools to identify, prioritize, and plan local actions that align with frameworks such as the Sustainable Development Goals (SDGs). It also addresses stakeholder participation and the mobilization of financing for implementation. Essentially, City WORKS acts as a guide for cities, enabling them to address urban challenges and align their local actions with global agendas.

In order to leverage synergies and combine existing tools with innovative methods, GIZ initiated the implementation of City WORKS in Bangladesh and Egypt. In Bangladesh, the City WORKS toolbox was applied as part of the GIZ Project Improved Coordination of International Climate Finance (ICICF), with a focus on promoting the localiz ation of the SDGs. In Egypt, it was applied within the GIZ Participatory Infrastructure Project (PIP), aiming to enhance the capacity of local government employees in evidence-based planning and monitoring of urban projects. This was achieved through training programmes for employees from eight governorates.

In both countries, the local counterparts of GIZ led the projects and collaborated with other local organizations, academic institutes, and local government bodies to ensure the successful coordination of project activities.

Other projects involving GIZ

Further projects involving the GIZ also take this approach. Some such projects include,

1. The GIZ established an open platform for innovation within the Green Urban Mobility programme in India commissioned by the Federal Ministry

of Economic Cooperation and Development (BMZ), running from 2021 to 2024 (GIZ, 2022). This platform uses the terminology of "Living Lab" or "Green Urban Mobility Innovation Living Lab", integrates the dimension of cooperation between diverse stakeholders (representatives from city administrations, research institutions, civil society and private companies such as Bosch India), the desire to prototype green urban-mobility solutions, and the intention to develop a methodology allowing replication of successful elements across Indian cities past the initial focus in Bangalore (ibid, TUEWAS ASIA, 2022). In this sense, this lab appears to include several key elements of an Urban Living Lab approach. An in-depth analysis is, however, not feasible as the project is in its initial stage or as online sources do not report details on prototypes tested or results yet.

2. The "Promoting sustainable urban development in intermediate cities" project (2021-2024), which includes six "urban laboratories" in Ecuador (Ambato, Cuenca, Lago Agrio, Loja, Latacunga, Portoviejo) to develop local investment projects and financing and implementing specific measures, with the explicit aim to produce knowledge on sustainable urban development and climate protection, through exchange between participants and peer (GIZ, 2022). Online sources do not explicit whether it includes elements of co-creation in the sense of testing, iteration and feedback.

3. Together with a large number of partners, GIZ is a member of the PREVENT Waste Alliance, launched in 2019 by the BMZ and with the participation of multiple German stakeholders such as the KfW Development Bank, the Deutscher Landkreistag, the German Environment Agency (UBA), the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), German research institutions such as the Wuppertal Institute for Climate, Environment, Energy, INAS GmbH – Institute for Applied Sustainability, Kassel University, Technische Universität Braunschweig, the Institut für sozial-ökologische Forschung – ISOE, the Ostbayrische Technische Hochschule Amberg-Weiden, and several others.

   PREVENT enables the implementation of a wide diversity of waste-related and lab-like pilots across the globe. Desk research shows that at least three key elements of an Urban Living Lab approach appear: geographical embeddedness, a collaboration between diverse and complementary stakeholders, and capacity-building to create and disseminate knowledge, for instance, via training sessions (PREVENT, n.d.). From online resources, it is unclear whether these pilots include co-creation with users, e.g. citizens, and the possibility for them to propose iterations based on the experimentation of the tested solutions. In some of the pilots, some stakeholders do not seem involved, such as representatives from the private or knowledge partners (e.g., ReduCE-waste: controlling e-waste imports in Tanzania), whereas other projects focus on peer learning between one type of stakeholders such as universities (e.g., the German MENA university network for waste

management and circular economy in Algeria, Morocco, Jordan, Egypt).

4. Lastly, other initiatives with GIZ involvement in the past included a lab wording, such as the GIZ Urban Innovation and Leadership Lab, launched by GIZ's Global Leadership Academy, and the strategy think tank Impact Solutions. This project includes a clear focus on peer exchanges and capacity building, with 26 urban practitioners meeting in various cities across the globe in 2015 and 2016 (Global Leadership Academy, 2015). The elements of real experimentation and iteration of innovation do not seem to appear in the information available through online resources.

6.1.2 Projects led by other German organisations

Further programmes implemented by other German stakeholders follow an Urban Living Lab approach or include elements of the approach.

1. The project entitled "Transformative Urban Coalitions" (TUC), funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) under its International Climate Initiative (IKI), brings together the German Institute of Development and Sustainability (IDOS), the United Nations University – Institute for Environment and Human Security (UNU-EHS), the World Resources Institute (WRI), and the International Institute for Environment and Development (IIED) (UNU-EHS, n.d.). The project, implemented between 2021 and 2023 and focusing on Latin America with five Urban Labs in Mexico, Brazil and Argentina, tested new models of coalition building and governance of "urban labs". The project uses the terminology of "Urban Labs", explicitly recognising the key components of experimentation, co-creation, diversity of participants, capacity building, as well as research and communication, to achieve a transformative effect towards sustainability (TUC, 2023).

2. The University of Stuttgart and the Fraunhofer Institute for Systems and Innovation Research (ISI) are two further German stakeholders exploring a similar approach with the Morgenstadt Global Initiative, also funded by BMU through IKI, where "city labs" are implemented in Saltillo (Mexico), Piura (Peru) and Kochi (India), exploring the development and implementation of sustainable transformation processes. (Fraunhofer ISI, 2021). The project starts with the creation of a city sustainability profile, followed by visits, meetings and workshops in collaboration with local actors, leading to the development of a strategic roadmap in co-operation with local actors, identification of subsequent projects, implementation and financing (mgi, 2023a). Residents and local actors were involved through stakeholder meetings, participatory workshops, and training (mgi, 2023b).

3. Lastly, programmes using a lab wording focus on one component, for instance, peer learning between one type of stakeholder (e.g., between

universities, e.g., WITS-TUB-UNILAG Urban Lab to test new digital methods and tools for collaborative teaching and research).

6.2 Barriers and Potentials

Embedding Urban Living Labs in development cooperation can face several barriers, which may vary depending on the context and specific circumstances. Some common barriers to consider:

- Institutional and Policy Challenges: The current institutional and policy frameworks for development cooperation may not be suitable for Urban Living Labs' principles and methodologies. The bureaucratic structures and traditional decision-making processes, in particular of public authorities, may impede the flexibility and innovation required by living labs. This is especially important to ensure the involvement of non-governmental entities and private entities such as businesses and existing solutions providers. Not involving a diverse group of stakeholders can lead to solutions that are complex, require a lot of resources, are ultimately not really or fully tested, and thus possibly difficult to scale or replicate.

- Limited Local Engagement: Engaging local stakeholders, such as communities, residents, and local governments, is crucial for the success of Urban Living Labs. However, achieving active participation and buy-in from these stakeholders over sufficient time can be challenging. Lack of awareness, limited capacity, and resistance to change may impede effective collaboration and hinder the integration of living labs into development cooperation. Inadequate stakeholder mapping or working with a pre-defined stakeholder group could result in lacking perspectives while coming up with a locally appropriate solution. Another pitfall may be the absence of a "local champion" or local organisation committed to the ULL?, as it is a strong enabling factor for the success of the lab.

- Resource Constraints: Urban Living Labs require financial resources, technical expertise, and infrastructure support. Limited funding and resource constraints in development cooperation programmes can pose significant barriers to establishing and sustaining living labs. Securing long-term financial commitments and ensuring access to necessary resources can be challenging. Development cooperation projects not specifically focussing on implementing Urban Living Labs may not completely grasp the resources required and could implement "pilot projects" incorrectly labelled as living labs.

- Coordination and Collaboration: Development cooperation involves numerous groups, including government agencies, NGOs, private sector actors, and community organisations. However, coordinating and aligning their interests, priorities, and expertise can be challenging due to power

dynamics, conflicting agendas, and a lack of shared understanding. This can hinder scaling up and replication if cooperation partners are not inclined to cooperate and to build upon projects led by other organisations. Similarly, openness and transparency, which are required to learn from experimentations, even from unsuccessful components or challenges encountered, may be difficult due to power dynamics.

- Contextual Adaptation: Urban Living Labs must be tailored to the unique challenges and characteristics of the specific urban environment for maximum impact. Understanding local dynamics, cultural factors, and socio-economic conditions is crucial for success. While the problems may look similar in various cities, every living lab is an independent experiment, and hence the boundary conditions need to be evaluated prior to every urban living lab.

- Knowledge and Capacity Gaps: Urban Living Labs require diverse skills and knowledge from various fields. Training for local actors, such as researchers, practitioners, and policymakers, is crucial to effectively participate and contribute. However, building capacity can be challenging in certain development cooperation contexts.

Although there may be some challenges, the potential for utilising urban living labs in development cooperation is significant. Let's take a closer look at some key factors to consider:

- Participatory and Inclusive Approach: ULL prioritise community involvement in urban development. By engaging residents and stakeholders in decision-making, ULL can create interventions that are customized to their unique needs and aspirations. This participatory approach fosters the development of sustainable solutions that are locally owned. DC projects can leverage the ties with the decision-makers to enable the participation of various stakeholders.

- Contextual Relevance: ULL create customised solutions for urban challenges by tailoring techniques to the local context, based on local needs. This allows for valuable insights and solutions that match the distinct characteristics of the urban environment. Development cooperation work can suggest experience from other countries as a starting step to learn from these cases, for instance through dedicated capacity-building and peer exchange, and develop local solutions .

- Innovation and Co-Creation: ULL foster innovation through collaboration and experimentation among stakeholders. They are ideal for development cooperation programmes to test new technologies and tackle urban development challenges. The cross-sector partnerships formed in ULLs bring diverse perspectives and expertise together. Though co-creation is

not always founding in development cooperation, embedding the idea of an urban living lab in early cooperation design can enable a co-creative process.

- Learning and Knowledge Sharing: ULLs offer a chance to test and improve interventions. They can also be used to share knowledge and exchange learning between local actors, researchers, practitioners, and policymakers, transferring best practices to different contexts. Knowledge and experience sharing is a cornerstone of DC, and through knowledge sharing, DC projects can allow partners to leapfrog .

- Scalability and Replicability: The success of living lab initiatives can serve as a valuable blueprint for implementing similar interventions in other urban areas. By leveraging the information and evidence gathered from living labs, DC programmes can provide policy recommendations, influence urban development strategies, and facilitate the replication of successful initiatives in diverse locations.

- Holistic and Integrated Approaches: ULLs are an effective tool in promoting a comprehensive and inclusive approach to city development that considers social, economic, and environmental aspects. When it comes to development cooperation initiatives, utilising living labs can help to tackle various sustainable development goals simultaneously, including reducing poverty, establishing sustainable infrastructure, promoting social integration, and fostering environmental sustainability.

6.3 Implementation

This guide has established a working definition of Urban Living Labs, presented the various characteristics and typical participating groups, and explored the building blocks of an urban living lab . This section dwells on a potential process to implement an ULL in DC.

Schematically, two phases are identified: before the setting up of the ULL and after its establishment. Table 4 provides a quick snapshot of these two phases, their correspondence to the 5Is framework, and the steps.

Phase 1: Pre-establishment	Phase 2: Post-establishment	
Identify	Act	Impact
• Identify the stakeholders • Formulate a vision and objective • Form a co-development group and develop thematic working groups	• Provide Capacity Building and Training (Inform as 1st I; Inspire as 2nd I) • Implement pilot projects (Initiate as 3rd I; Implement as 4th I)	• Impact: assess including via feedback loops; scale up and replicate (5th I)

6.3.1 Phase 1 (pre-establishment): Identify

By the end of this phase, it is expected that the practitioners have identified the key stakeholders they intend to work with and identified the key expert groups, businesses and entrepreneurs that can contribute to the ULLs. After this phase, all the stakeholders will have a common understanding of the ULL concept and the objectives and vision that their living lab will achieve.

Step 1. Identify stakeholders in an urban living lab

The first step is to identify and engage the representatives who will be part of the co-development group (local communities, the planning and construction industry, research and academia, local and national government, financial institutions, and the private sector). This step includes the following activities:

- Define the Scope: It is important to establish the scope and goals of the ULL. This involves identifying the specific urban issue or concentration area that the lab intends to tackle. Doing so will aid in identifying the key stakeholders who are involved in or affected by the challenge.

- Conduct Stakeholder Mapping: Conduct a stakeholder mapping exercise to identify the groups and individuals who have a stake in the urban challenge. This can be achieved through desk research, interviews, surveys, and consultations with experts, local authorities, community leaders, and other relevant stakeholders. The participatory approach methods discussed earlier in this chapter can be of use while doing the mapping exercise.

- Identify Key Actors: Identifying the key actors who can influence or contribute to a solution is important. As discussed in earlier chapters, this can include government agencies, community organisations, NGOs, expert groups, businesses, academic institutions, residents' associations, and other relevant entities, both formal and informal.

- Analyse Interests and Influence: It is vital to assess the power, resources, knowledge, and commitment of each stakeholder and prioritise them based on their potential impact on living lab activities.

- Engage Stakeholders: Engage stakeholders through workshops, meetings, focus groups and collaborative platforms. Encourage open dialogue and active participation in co-creating ideas and solutions. Keep stakeholders informed about progress and outcomes regularly.

Step 2: Develop a joint vision of the Lab's focus (vision building) and objectives

Urban Living Labs need a multi-stakeholder effort. There are various stakeholders and there are multiple perspectives in developing a solution. A

common vision and defined objectives will guide the development.

- Defining a vision: Collaboration is key to creating an inspiring vision for the urban living lab, addressing challenges and considering sustainability dimensions. A vision should be inspiring and aspirational while also addressing the identified challenges.

- Setting objectives: Once a vision is established, set objectives that align with the vision. The objectives need to be specific, measurable, achievable, relevant, and time-bound (SMART)

- Consider Multiple Perspectives: Make sure to include the viewpoints and concerns of various stakeholders when developing the vision and objectives. Consider various social, economic, environmental, and governance dimensions to ensure a well-rounded and thorough approach.

- Based on this, define specific, measurable, achievable, relevant, and time-bound (SMART) goals and objectives that the Urban Lab seeks to achieve.

Step 3. Form a Co-development Group

Divide the stakeholders into thematic working groups based on their areas of expertise and the objectives of the Urban Lab.

- Create joint working groups comprising representatives from various stakeholder groups and having thematic lead partners on specific topics, e.g., capacity building, impact assessment, etc.

- Conduct regular co-development meetings, where the working groups can collaboratively brainstorm, problem-solve, and design solutions to the sectoral and spatial challenges identified. It's crucial that these workshops are participatory, giving every stakeholder a voice. Establish clear and transparent decision-making processes that are open to input from all stakeholders.

- Encourage open dialogue, debate, and the sharing of ideas, ensuring that all voices are heard and considered in the development of sustainable urban solutions.

- Identify co-creation activities best suited to various participants in the Urban Living Lab, such as workshops, focus groups, face-to-face meetings, site walks, plenary meetings, design studios, gamification activities, etc., using different tools for different purposes and groups .

- Allow the group to deliberate on the various sites for implementing the ULL experiment. In some cases, the ULL is not necessarily an on-ground

implementation. In such cases, defining the project boundary will be the responsibility of the group.

6.3.2 Phase 2: Act and Impact

Step 4. Provide Capacity Building and Training

Equip the stakeholders with the knowledge and skills needed for participatory planning and co-development, including workshops on topics like climate-smart urban planning, sustainable construction, community engagement. Common capacity building activities will include:

1. Technical workshops: These workshops can either be an online feature or an in-person feature where the information on the topic is given considering the stakeholders are beginners. A self-paced online course can be of value in this approach. Upon completing the course, the participants will have increased their awareness of the topic that the ULL is addressing.

2. Webinars and expert discussions: These are interactive sessions, either online or in-person. Usually held in a session lasting 90 min. In these sessions, an expert is invited to share their experience on the topic, and sufficient time is allocated for the participants to share their views and clarify their questions.

3. Site visits: These are opportunities for stakeholders to experience solutions implemented elsewhere and learn from an on-ground implementation. It is important to define the scope of the site visit and the expected outcomes of the site visit. Defining these factors will enable selecting the right level of participation from each stakeholder. For example, a technical site visit may be less informative for a decision-maker, who might be more interested in the strategic decisions behind the implementation.

Another crucial factor in capacity building is maintaining a repository of all the knowledge that is developed during the ULL implementation. Ideally, such a repository needs to be housed at an entity that is neutral and has information dissemination as an inherent function. Universities and other academic partners can be good partners in being the guardians of the knowledge that is developed. In that way, the academia can actively use the knowledge in their curriculum and train future professionals on urban living labs.

Step 5. Co-Evaluate

Establishing strong monitoring, evaluation, and learning processes is essential for the lasting success of Urban Living Labs. These processes enable practitioners to assess the effectiveness of their methods and make necessary adjustments, promoting a culture of ongoing improvement . Develop Key Performance

Indicators (KPIs): Establish measurable KPIs that align with the objectives of the Urban Living Lab. These indicators should assess the progress and impact of the lab's initiatives and the effectiveness of participatory processes and collaborative efforts.

- Implement Regular Monitoring and Evaluation: Conduct regular monitoring and evaluation activities to assess the performance of Urban Living Labs against the established KPIs. This data should be used to inform decision-making and adjustments to the lab's strategies and approaches. This learning should be fed back into the process for continual improvement.

- Foster a Culture of Learning and Adaptation: Encourage participants to embrace a culture of learning and adaptation, recognising that Urban Living Labs are dynamic and iterative processes. Ensure that feedback and lessons learned are shared among participants and used to inform future initiatives.

- Disseminate Results and Share Best Practices: Share the results of Urban Living Labs with a wider audience, including policymakers, practitioners, and other Urban Living Labs. This helps build a community of practice and fosters the exchange of best practices and lessons learned.

Step 6. Scale Up and Replicate

Based on the successful elements of the pilot project and the Urban Lab process, plan for scale-up and replication in other urban areas. Scaling up and replicating solutions will depend on the following factors:

- Robust evaluation framework base on Step 6.

- A scalability assessment that can evaluate the adaptability of the solution.

- Prior planning of resources for scaling up or replication.

- Strong collaboration and openness to other stakeholders, especially businesses and entrepreneurs.

7.RECOMMENDATIONS

To successfully implement Urban Living Labs in a development cooperation setting, it is crucial to engage in strategic planning and carefully consider each step of the process. Based on the various projects reviewed and on the literature on living labs and urban living labs, we draw the following recommendations for embedding urban living labs in development cooperation.

- Engage local stakeholders: Active involvement and engagement of local stakeholders are crucial for ensuring the success of the process. This comprises representatives from government agencies, community organizations, academia, the private sector, and civil society. An inclusive approach promotes ownership, sharing of local knowledge and ultimately leads to achieving sustainable outcomes.

- Conduct contextual analysis: In order to guarantee the most impactful results, it is crucial to conduct a thorough analysis of the local environment. This involves investigating socio-economic, cultural, and environmental factors, as well as existing governance structures and institutional frameworks. By gaining an understanding of the unique urban challenges and opportunities, the Urban Living Labs can be tailored to the specific local context.

- Foster partnerships: Establishing partnerships and collaborations with various actors such as government agencies, international organizations, NGOs, research institutions, and local communities is crucial for effectively addressing urban challenges and implementing Urban Living Labs. These partnerships provide access to diverse expertise, resources, and networks, which can significantly enhance capacity and garner support.

- Develop a shared vision and goals: Our aim is to bring together all parties involved in the Urban Living Labs initiative through a participatory process that encourages the development of a shared vision and goals. By involving everyone in identifying desired outcomes, objectives, and success indicators, we can establish a mutual understanding and dedication to achieving sustainable urban development. This collaborative method promotes synergies among stakeholders towards a common goal.

- Apply co-creation methodologies: Prioritizing co-creation methods that facilitate collaboration, dialogue, and knowledge sharing is crucial. It is essential to encourage diverse stakeholders to contribute their perspectives, expertise, and ideas during the development of innovative solutions. The implementation of design thinking, participatory workshops, and co-design processes can ensure that decision-making is inclusive, and that Urban Living Labs are collectively owned. The decision-making power of all participants should be targeted at all stages (design, implementation, testing, evaluation), not only at the inception and co-design stage. Participation and feedback from diverse stakeholders can be eased through differentiated activities,

most adapted to each stakeholder and to the local context.

- Build local capacity: Investing in capacity building for local stakeholders is crucial to enhance the implementation of Urban Living Labs. This involves offering comprehensive training, technical assistance, mentoring and peer learning, including visits to improve skills in project management, data analysis, participatory approaches, and sustainable urban development practices.

- Establish monitoring and evaluation mechanisms: For the success of Urban Living Labs, it's crucial to implement robust monitoring and evaluation methods. This involves monitoring progress, measuring impact, and assessing effectiveness. Regular analysis of key indicators and review of outcomes and outputs is necessary. The findings from evaluations should be utilized to make informed decisions, fine-tune strategies, and enhance the implementation process.

- Promote knowledge sharing and replication: It would be beneficial to establish avenues for sharing best practices, success stories, and lessons learned from Urban Living Labs. Through workshops, conferences, publications, and online platforms, we can disseminate knowledge and experiences. This way, we can encourage the replication and adaptation of successful approaches in other contexts, thereby promoting learning and innovation.

- Evaluate and learn iteratively: Consistently evaluating the implementation and results of Urban Living Labs is crucial. It is important to take into account both positive and negative feedback and make any necessary adjustments to improve their effectiveness. By fostering a culture of continual learning and improvement, we can ensure the continued success of Urban Living Labs over the long term. Sufficient time needs to be planned and dedicated to this activity, and feedback loops, as well as iterations, should be possible.

- Ensure long-term sustainability: When designing and implementing Urban Living Labs, it's important to consider sustainability. This includes figuring out how to finance and gather resources for the long-term and making sure that the solutions created through the labs are integrated into urban policies and strategies for lasting impact on sustainable urban development. Cooperation with development partners to pursue and amplify the pilot's results is desirable.

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Unsplash

9. ANNEX I – DEFINITIONS OF URBAN LIVING LABS

Author	Definition
ENOLL, 2013	"Living Labs (LLs) are open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of innovation to create sustainable impact. They focus on co-creation, rapid prototyping & testing and scaling-up innovations & businesses, providing (different types of) joint value to the involved stakeholders. In this context, living labs operate as intermediaries/orchestrators among citizens, research organisations, companies and government agencies/levels. Within a wide variety of living labs, they all have common characteristics but multiple different implementations."
Westerlund and Leminen (2011)	Living labs are "experimentation environments; they are 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."
JPI Urban Europe	Urban Living Lab: "A forum for innovation, applied to the development of new products, systems, services, and processes in an urban area; employing working methods to integrate people into the entire development process as users and co-creators to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex and everyday contexts.
von Wirth et al. (2018)	Urban Living Lab: "ULL represent sites in cities that allow stakeholders to design, test and learn from socio-technical innovations in real-time. Participation, experimentation, and learning are put centre stage." (...) "ULL combine both an urban location as well as a focus on experimentation."
Bulkeley et al. (2017)	"An explicit form of intervention delivering sustainability goals for cities. Established at the boundaries between research, innovation and policy, ULLs are intended to design, demonstrate and learn about the effects of urban interventions in real time.
Steen & van Bueren (2017)	"The term "Urban Living Lab" is to refer to a variety of local experimental projects of a participatory nature.") completed by the four dimensions and nine sub-dimensions identified."
Voytenko et al. (2016)	Urban Living Lab: "a form of collective urban governance and experimentation to address sustainability challenges and opportunities created by urbanisation."

Author	Definition
Mahmoud et al. (2021)	Urban Living Lab: "a common type of co-creative container of experimentation, offering the opportunity to research and innovation on a wider variety of challenges in everyday settings and test hypotheses and elements concerning pathways for transitions toward urban sustainable living." (...) "In most cases ULLs work as an advanced and explicit form of intervention in delivering sustainability goals for cities by running (social, ecological, and technological) experiments" (...) "in this paper, we investigate the concept of ULL as the container or medium of intervention in the urban arena" (...) "we look at ULLs as the "medium" or the spatial context container through which the co-creation pathways are encouraged to take place whether physically, virtually or by any mean of engagement,' (...) "ULLs can also be viewed as spaces designed for interactions between a context and a research process to test, develop and/or apply social practices and/or technology to a building or infrastructure due to their focus on co-creation through experimentation through explicit geographical embeddedness (Franz, 2015; Voytenko et al., 2016, 46–47; Van Montfort and Michels, 2020)."
Chronéer et al., 2018	"ULL is a local place for innovative nature-based solutions that aims to solve urban challenges and contribute to long-term sustainability by actively and openly co-constructing solutions with citizens and other stakeholders."
Juujärvi and Pesso (2013)	"An Urban Living Lab can be seen as a special type of regional innovation network that puts emphasis on residents and their communities as users (i.e., ordinary people who want to solve their real-life problems)."
Nesti (2017)	"Urban Living Labs (ULLs) represent a good example of methodology based on co-production and aimed at coping with policy challenges occurring at the local level."