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Living Labs for Sustainability

Silvia Sayuri Mandai[1] and
Fernanda da Rocha Brando[2]
[1]School of Arts, Sciences and Humanities,
University of São Paulo,
São Paulo, SP, Brazil
[2]Department of Biology, Faculty of Philosophy,
Sciences and Letters of Ribeirão Preto,
University of São Paulo,
Ribeirão Preto, SP, Brazil

Synonyms

Living laboratories for sustainability

Introduction

Studies have pointed out that human activities have reached a level which can damage the systems of Earth or exceeded crucial ecological limits/planetary boundaries (Rockström et al. 2009; Steffen et al. 2015). These patterns of consumption and production are associated with populations' lifestyles, such as global extraction in a much faster rate than what our global ecosystem can regenerate, use of natural resources, and the release of waste and emissions from their use (Millennium Ecosystem Assessment 2005; Rockström et al. 2009; UNEP 2010; Steinberger et al. 2013; Steffen et al. 2015).

Then, it is necessary a holistic approach which englobes and optimizes the entire production-consumption-system (Liedtke et al. 2012). This issue depends on individual decision-making and behavioral actions combined with processes of organizational learning, including the social context (Sanne 2002; Reisch and Ropke 2005; Biel and Thøgersen 2007; Wenger 2007). Hence, more studies are needed, especially about what people want and how they use products and frameworks in their living environment (Shove 2003, 2005; Warde 2005).

In this context, design processes represent sociocultural, economic, and environmental trends, connecting the user, the consumer and the producer. Furthermore, sustainable design is a key to avoiding, minimizing, and improving the environmental impacts of products and services (Liedtke et al. 2012). Also, it can suppport the restructuring of the state and the emergence of new ways of institutional innovation (Bulkeley and Broto 2012). In this point, it is relevant a user-oriented design, which integrates users and all relevant stakeholders in the value chain, reducing consumers' acceptance problems in the future, for example (Feurstein et al. 2008; Liedtke et al. 2012). Thus, the design processes are connected to the ideia of experimentation and this approach is related to the living labs. Concept, such as the design of urban political spaces through which strategies to avoid or minimize climate change's effects can be pursued (Bulkeley and Broto 2012).

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Living Labs

Definitions and Historical of "Living Lab"

The word "laboratory" (lab) is defined as a building or a room where scientific experiments, analyses, and research are carried out (Collins Dictionary – available at https://www.collinsdictionary.com/dictionary/english/laboratory). Aiming to test hypotheses, the labs allow variables to be isolated and carefully manipulated (Knorr-Cetina 1995), creating enhanced environments where it is possible to see things not visible easily (Henke and Gieryn 2008). However, the idea that the "lab" can be separated from "reality" has been widely criticized (Gieryn 2006). This way, the approach of living labs enables to redefine the meaning of experimenting and innovating (Evans and Karvonen 2011).

In this context, the term "living lab" was initially used to observe, for a period, the living patterns of users in a smart home, a proposition of Professor William Mitchell at MIT (Bergvall-Kåreborn et al. 2009). It has arisen based on innovation and entrepreneurship, as an open business network (Nystrom et al. 2014). Since then, the approach has become broader: living labs to enhance innovation, inclusion, usefulness, and usability of information communication technology (ICT) and its applications (Eriksson et al. 2005). However, there is no consensual definition of living lab. There are two main perspectives. As a milieu, an environment, an infrastructure, an arena. Also, as a methodology, a systemic innovation, an approach for intentional collaborative experimentation of researchers, citizens, companies, and local governments in a user-centric perspective (Bergvall-Kåreborn et al. 2009; Schliwa 2013). Hereafter, we will present more details.

In a milieu point of view, it is seen as an experimentation environment in which technology is given shape in real-life contexts and in which users are considered "co-producers" (Ballon et al. 2005). As well, physical regions, virtual realities or spaces of interaction, where all stakeholders join together to create, develop, test, and implement new products and services in a real-life context (Nystrom et al. 2014). Furthermore a geographical or institutionally bounded space, where are conducted intentional experiments that make social and material alterations, incorporating an explicit element of iterative learning (Evans et al. 2015).

Besides, a living lab can be considered an arena for innovation: a systemic innovation approach in which all stakeholders participate directly in the development process of a product, service, or application (Feurstein et al. 2008).

Moreover, as a methodology, a living lab is defined as "a user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts" (Eriksson et al. 2005, p. 4). The concept involves staging intentional experiments in real-world settings which are then validated collaboratively and monitored, enabling the researchers to make conclusions (Feurstein et al. 2008; Voytenko et al. 2016).

In an approach for integrative collaboration, it can be characterized to constitute a form of experimental governance, whereby stakeholders develop and test new technologies and ways of living to address the challenges of climate change and urban sustainability (Evans et al. 2015). Also it is described as "an integrated technological, socio-economic approach that enables optimized interaction of production and consumption by mirroring, explaining, and integrating emerging trends and consumer behavior" (Liedtke et al. 2012, p. 108). It prioritizes long-term measures and the engagement of users rather than restricting or designing around them (Liedtke et al. 2012). It also represents partnerships between sectors. Living labs can be understood to "sidestep the tensions between bottom-up and top-down approaches to innovation in favor of lateral partnerships" (Evans and Karvonen 2011, p. 136) and to "validate products and services in collaborative, multi-contextual, empirical, real-world environments, integrating users and stakeholders" (Evans and Karvonen 2011, p. 129).

Comprehending both an arena and an approach, living labs are characterized as "a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in

real-life contexts, aiming to create sustainable values" (Bergvall-Kåreborn et al. 2009, p. 3).

Additionally, the expression living lab includes infrastructure and socioeconomic issues: "a combined lab-/household system, analyzing existing product-service systems as well as technical and socio-economic influences focused on the social needs of people, aiming the development of integrated technical and social innovations – new product mixes, services and societal infrastructures – and simultaneously promoting the conditions of sustainable development and respecting the limited numbers of natural services that can be used without destroying the ecological system" (Liedtke et al. 2012, p. 109).

Based on the environmental challenges, the living labs for sustainability were proposed. Considering that creating a more sustainable society is increasingly an urban challenge (Pincetl 2010), cities are becoming key sites to develop long-lasting solutions to climate change (Bulkeley and Broto 2012; Hodson and Marvin 2007) and sustainability. In this panorama, living labs to drive innovation in sustainable urban development have been proposed and studied (Evans and Karvonen 2011). In this chapter, both perspectives of living labs will be considered.

Urban living labs (ULLs) constitute a form of experimental governance, whereby urban stakeholders, aiming to produce innovative solutions to the challenges of climate change, resilience, and urban sustainability, develop and test new technologies, products, services and ways of living (Bulkeley and Broto 2012; Voytenko et al. 2016).

ULLs can also be understood 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" (Voytenko et al. 2016, p. 46). Moreover, they are described as "sites devised to design, test and learn from innovation in real time in order to respond to particular societal, economic and environmental issues in a given urban place" (McCormick and Kiss 2015, p. 45). Considering ULLs' recent and rapid proliferation, studies have been conducted to understand whether living labs may help in the government of urban sustainability and low carbon transitions (Voytenko et al. 2016).

ULLs are distinct because their targets are on knowledge and learning as a means through which such interventions can be successfully achieved (Voytenko et al. 2016). Moreover their objectives are the co-creation and empowerment of diverse stakeholders, putting together science, policy, business and civil society (Voytenko et al. 2016) in an open and participatory way.

In the area of sustainability, living labs involve some applied problems, such as built design, green infrastructure, and low carbon technologies through collaborative experiments, integrating users and stakeholders as co-producers of knowledge (Evans et al. 2015).

The spaces designated as living labs are very variable, such as universities, government bodies, and private companies (Evans and Karvonen 2011). The living lab approach has become popular with universities around the world because they have recognized that their campuses offer accessible real-world conditions where it is possible to conduct applied research (Evans et al. 2015). It is a way to propose alterations in our society according to new knowledge (Evans and Karvonen 2011). This approach is commonly referred to as "living lab" or using the "campus as a classroom" (IARU 2014). In the next section, some practical examples of the previous concepts will be presented focusing mainly on Universities.

Universities as Living Labs for Sustainability

Universities are potential environments to study sustainability challenges because they can simulate small towns, acting as ULLs (Alshuwaikhat and Abubakar 2008). Sustainability in a University includes several sectors, like classrooms, laboratories, housing, transportation and other services (Alshuwaikhat and Abubakar 2008). The campuses comprise many people (students, teachers, and staff), different activities and buildings of various ages and types (Evans et al. 2015). Some also have student residences to manage, like at the University of Manchester and University of São Paulo (Evans et al. 2015; Mandai and Brando 2018). In this context, several universities have

committed to implementing sustainability practices in their institutions (Lozano et al. 2013), such as education, research, community participation, and campus operations (Cortese 2003; Alshuwaikhat and Abubakar 2008; Fadeeva and Mochizuki 2010; Leal Filho 2011; Müller-Christ et al. 2014).

Universities also have the responsibility for visioning a more sustainable future as they educate the future leaders of the world (IARU 2014). It comprises applying research and education to test real-time sustainability solutions in the campuses (IARU 2014; Konig and Evans 2013). The core point of the living lab is its systematic approach, in which it is possible to harness the academic capacity of universities to address the challenges of sustainable development (IARU 2014). The University Living Lab of the University of Manchester (United Kingdom) is an example. The initiative started in 2012 to transform the campus in a site for applied teaching and research around sustainability challenges of the real world, engaging students and academics (Evans et al. 2015).

Another instance is the Living Laboratory for sustainability of the University of Cambridge (United Kingdom). Its goal is to improve the environmental performance of the university applying knowledge to the real world while enhancing skills of those involved through projects, internships, and research (IARU 2014). It also looks to be a platform for research and a tool for management of environmental practices of the university. Another case: the University of Copenhagen (Denmark), which intends to be an international model of sustainability for universities by focusing on systemic solutions (Green Campus 2013). One of its strategies is the living lab for the development of tomorrow's sustainability solutions that University itself researches and teaches (Green Campus 2013).

Living labs' activities are usually centered in or related to the sustainability offices of the Universities, which support the development and experimentation of new technologies and ways of living in a governance approach. These are the cases of the Superintendence of Environmental Management (University of São Paulo, Brazil) and the Green Campus Office (University of Copenhagen). Similar challenges were pointed out for these agencies: engaging people, approving projects, obtaining financial support, creating and disseminating content, motivating different managers through dialogues, and conducting projects (Mandai and Brando 2018).

By including sustainability in an institution's teaching, research, and operations, the university creates an environment to act as a change agent (IARU 2014; Konig and Evans 2013). One of the primary ways to do so is to address a firm grounding in the sustainability concepts and issues in diverse disciplines (Leal Filho 2011; Konig and Evans 2013; IARU 2014; Müller-Christ et al. 2014). The University of Manchester reported that there were 112 courses related to sustainability teaching with approximately 7000 students distributed across 11 schools from 2012 to 2013 (Evans et al. 2015). This University is seeking to integrate students into ideas around sustainable development in a nonprescriptive manner, like including living lab student projects into the curriculum (Evans et al. 2015). The challenge was to turn these opportunities into short time projects using resources available within the University (Evans et al. 2015).

Furthermore, living lab projects offer for students and academics the possibility to convert theory to practice, as well as it facilitates people's engagement with applied sustainability issues (Konig and Evans 2013). At the University of Copenhagen, the project Wild Campus sought to bring nature closer to people in some spaces of the University by planting ten thousand seeds of Danish native plants (Science 2016). The species were selected using the knowledge of specialists of the Center of Macroecology, Evolution, and Climate (Science 2016). This way, it was an opportunity to put the theory to practice in the University. Moreover, this research group is part of the Sustainability Science Centre, which aims to integrate researchers, businesses, and decision-makers with different academic backgrounds to solve society's new challenges, one of the ULLs' characteristics (Voytenko et al. 2016).

Living labs also include employees who will be more likely to align their behaviors with the

needs of the organization to achieve their collective goals (IARU 2014; Müller-Christ et al. 2014). Next, we will present some instances. Aiming to expand the integration of sustainability issues into University and to promote sustainable articulated actions, the University of São Paulo had a program called PAP (People that learn Participating), which sought to form and engage the University's employees in a critical and emancipatory perspective of environmental education from 2013 to 2015 (Meira et al. 2014; Sudan et al. 2015). The University of Copenhagen has tried to engage people by the Green Ambassadors' influence. These are students and staff who help the Green Campus office to share and put in practice its recommendations at their workplaces trying to engage people in their daily lives (Green Campus 2014).

Similarly, the University of California, Berkeley (United States of America) had a project called WORKbright green, which englobed staff sustainability training (over 60 employees) (Evans et al. 2015). The goal was to improve sustainability actions in the workplace and at home, to bring green projects back to the office, and to collaborate with other campus sustainability (Evans et al. 2015). The cases mentioned had some points in common, such as the issues treated in their projects (e.g., energy and waste management) and the diffusion of sustainability ideas by forming and engaging people and bringing theory to practice (Mandai and Brando 2018).

Hereafter, we will consider living labs more in an arena perspective associated with sustainability operations. In these situations, it is possible to see partnerships between universities, public sector, and private companies (Evans et al. 2015). The Green Lighthouse at the University of Copenhagen was an attempt to test new technologies and ways of living, seeking to reduce the emissions related to climate change. It was Denmark's first public carbon-neutral building, which was a partnership between the public university, the government, and the private sector (IARU 2014). For the same University, in the area of sustainability, it was reported a focus mainly on infrastructure, such as automatic energy control, monitoring water consumption, solar panels to energy production and to heat the water, buildings with low-carbon production, as the cited Green Lighthouse, and investment in low-carbon equipment (Mandai and Brando 2018). In a long-term perspective, the University of Manchester proposed a new engineering campus as a living lab for applied teaching and research, where students and academics could apply social practices and technology into the buildings (Evans et al. 2015).

In the field of transport operations, Peking University (China) actively encourages walking and cycling by placing cars outside the campus (IARU 2014), while it decreases campus traffic, energy consumption, pollution, and emissions. There are two main strategies: car-parking spaces in the areas around the University and a shuttle-bus service to give staff and students an alternative way of getting to different campus sites (IARU 2014). Likewise, the Australian National University (Australia) has incentivized the use of more sustainable transport modes since the 1990s, such as the university's carpooling program (IARU 2014). It included the construction of bicycle infrastructure across campus and the establishment of Australia's largest corporate bicycle fleet (IARU 2014).

The last University also has experienced waste management operations with the ANU organic waste recycling program diverting around 136 tonnes of food and biological waste from landfill each year (IARU 2014). Most of the material comes from dining halls and a smaller portion from research areas, which are converted to compost after (IARU 2014). This method is more sustainable than landfills, reducing the production of methane and other greenhouse gases (IARU 2014).

Considerations and Future Challenges

This entry presents some experiences of some Universities around the world, seeking to transform their campuses into urban living labs for sustainability, putting into practice the knowledge learned and produced. This way, besides their sustainability practices, they have the potential to be examples of cities trying to enhance the

broader sustainability. That's the capacity to transform the contexts by education, research, implementing practical operations, as well as consulting and engaging stakeholders (Liedtke et al. 2012; Evans et al. 2015; McCormick and Kiss 2015; Voytenko et al. 2016).

However, the living labs have some challenges. First of all, creating a living lab that suits the needs and internal structure of the University, including what works better for employees and students (IARU 2014). Moreover, despite the living labs aim to influence the broader world, the precise strategy or mechanism to scale up these projects, policies, and plans are rarely delineated explicitly (Evans and Karvonen 2011). In general, innovative practices are assumed to somehow infiltrate and propagate into the real world and become the norm (Evans and Karvonen 2011). Nevertheless, the next steps concerning the living labs are still uncertain, mainly about the widespread changes in the existing processes of urban development (Evans and Karvonen 2011). This process will depend on how the results obtained based on the experiences are package and transferred to other circumstances (Evans and Karvonen 2011).

Thus, the educational strategies and the programmes about sustainable development in University "can only succeed if schemes aimed at informing and mobilising people are combined with relevant structural measures such as campus greening, a robust sustainability research programme or a set of concrete, practical demonstration projects" (Leal-Filho 2011, p. 437).

Therefore, the promotion of an active and more sophisticated sustainability discussion, planning, and actions in universities is what will allow communities to craft the future they desire (IARU 2014). Then, staff and students engagement is relevant to promote environmentally responsible behavior, providing sustainability education to all students, as well as offering a best-practice operational model to society (IARU 2014). These actions may motivate other institutions and communities to set similarly ambitious goals, projects, and activities (IARU 2014). Likewise, a collaboration involving sustainability issues can lead to a greater feeling of ownership and responsibility among both employees and students, supporting a broader culture of sustainability at the university (IARU 2014).

Cross-References

- Campus as a Classroom
- Experimental Governance
- Experiments
- Knowledge Co-creation
- Sustainability Transitions
- Sustainable Design
- Urban Living Labs
- User-Driven Innovation for Sustainability

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