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Sustainability of living labs in a smart city context: a conceptual framework on business model design

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Executive summary

This paper introduces a specific type of innovation intermediary, which is frequently cited in the context of quadruple helix innovation and the realization of the SDGs, the so-called 'Living Lab'. The focus then turns to living lab literature, the three different levels of analysis within living lab phenomena and an empirical observation of the sustainability of living labs. Recently, we observe a proliferation of living lab initiatives and at the same time high mortality rates among accredited living labs. So far, research lacks of comparative studies on their business models, which would allow an assessment of their sustainability. Empirical findings and a case study are used as a means to design a conceptual framework model to pave the way for a comparison of different initiatives and their organizational structure. We distinguish among four different types of living labs and give an outlook on future research steps and potential hypotheses.

Introduction and background

The European Commission (EC) recently elaborated on its mission-oriented research approach[1]. Due to the distributed nature of excellence and expertise, and the different levels of economic development, Europe requires a different approach in terms of innovation policy. Therefore, the EC defines its key policy goals as 'missions' that are to be attained by distributed efforts in the different member states that somehow operate in concert.

The Sustainable Development Goals (SDGs) act as a guiding light to define these missions[2]. However, besides the distributed and dispersed nature of resources, knowledge and means in Europe another element increases the complexity of managing this type of mission-oriented innovation processes. This is so, for societal challenges, which are complex and tackle real people's lives, something that is referred to as 'wicked societal problems'. The SDGs provide a point of reference to the types of challenges that need to be tackled, but do not offer concrete solutions. To find these solutions one must first learn how socio-economic issues interact with policy making and technology. This kind of systemic innovation, where civil society is also seen as an equally important actor, is referred to as quadruple helix innovation. To facilitate quadruple helix innovation, local innovation intermediaries must orchestrate and align the spheres of public, private, research and civil society in innovation activities. A specific type of innovation intermediary, which is frequently cited in the context of quadruple helix innovation and SDGs is the so-called 'Living Lab'. We regard this mostly European phenomenon, which is also witnessing a worldwide uptake, as a key actor for the realization of Europe's mission-oriented approach, as well as in the achievement of the SDGs. However, there is a lack of studies and knowledge as to the sustainability of these organizations themselves.

Today, we are observing a proliferation of different living lab initiatives. Some of them have existed for many years and tend to be very successful, whilst many disappear after a short period of time. Until today, we had difficulties to distinguish clear types of living labs and to draw conclusions about their business model design. So far, the characteristics of a living lab's business model are described in a rather vague and qualitative way only. In this paper, we build a conceptual framework model to facilitate further research regarding the potential sustainability of these crucial organizations and to allow a comparison of different initiatives and the structure of their business models.

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[2] United Nations. 2018. Sustainable Development Knowledge Platform, https://sustainabledevelopment.un.org/post2015/transformingourworld.

Living labs & sustainability

The term 'Living Lab' was already used before 2006 to describe the mostly American phenomenon where a lab was created to resemble a real-life living environment[3], but the 'big bang' of the concept was popularly dated back to 2006 when the European living lab movement started to blossom[4]. Almirall & Wareham (2011)[5] define these European living labs as *"(...) semi-partitioned spaces in the form of innovation arenas integrated in real-life environments but separated by means of an innovation project structure that cultivate user-led insights"* and *"(...) infrastructures that surface tacit, experiential and domain-based knowledge such that it can be further codified and communicated"*. In terms of conceptualization, Schuurman (2015)[6] proposed to make a distinction between three different levels of analysis within living lab phenomena, based on the observation that living labs are complex entities with various activities and interactions taking place between different actors. The three layers that can be distinguished are: (1) the macro or **organizational level**, where living labs are Public-Private-People partnerships[7], (2) the meso or **project level,** which consist of a concrete innovation project carried out within the living lab organization, and (3) the micro or **user activity level**, which entails the individual user co-creation activities within an innovation project.

One gap in the current living lab literature is the lack of comparative studies on business models[8]. For those studies and reports that do take the business model aspect into account, we can generally distinguish three ways in which business models are discussed in the context of living labs:

1) Within a large amount of the studies, business modelling is considered at the meso level, stating that living lab projects might provide insights not only on user needs and practices, but also on new business model opportunities ([9, 10, 11, 12, 13, 14, 15, 16, 17]). However, after making such general statements, the focus of these studies usually turns entirely back towards the user research part, leaving the business model aspect undefined and providing no practical guidelines whatsoever on how to make the link.
2) The largest share of the studies considers multi-actor living lab consortia and the collaboration model between these partners as a key issue in securing a sustainable and

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[6] Schuurman, D. 2015. Bridging the Gap between Open and User Innovation? Exploring the Value of Living Labs as a Means to Structure User Contribution and Manage Distributed Innovation. Doctoral Dissertation. Ghent University. Faculty of Political and Social Sciences; Vrije Universiteit Brussel. Faculty of Economic and Social Sciences, Ghent; Brussels, Belgium.

[7] Leminen, S. 2013. Coordination and participation in living lab networks. *Technology Innovation Management Review, 3*(11).

[8] Rits, O., Schuurman, D., & Ballon, P. 2015. Exploring the Benefits of Integrating Business Model Research within Living Lab Projects. *Technology Innovation Management Review, 5*(12): 19-27. http://timreview.ca/article/949.

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[15] Schaffers, H., Merz, C., & Guzman, J. G. 2009. Living Labs as Instruments for Business and Social Innovation in Rural Areas. In Proceedings of the *2009 ICE Conference, Leiden, The Netherlands*, June 22–24.

[16] Schuurman, D., De Moor, K., De Marez, L., & Evens, T. 2011. A Living Lab Research Approach for Mobile TV. *Telematics and Informatics, 28*(4): 271–282.

[17] Svensson, J., & Eriksson, C. I. 2009. Open Innovation in Small Enterprises – A Living Lab Approach. Paper presented at the *XX ISPIM Conference Vienna, Austria*, June 21–24.

long-term collaboration agreement ([18, 19, 20, 21, 22, 23, 24]). In these studies, that link business modelling to the macro level, the lack of a good business model is considered to be a major possible roadblock to open innovation within living labs.

3) The smallest number of studies focuses on the business model of the living lab platform itself as a way to become self-sufficient and generate enough revenues from the services provided ([25, 26, 27, 28]). These studies, taking into account both the macro and meso level, discuss what the market needs from living lab platforms, stipulating best practices of the type of assets (resources) and activities (services) a living lab should offer to the market.

With this paper, we want to dig deeper into the underlying business models for living lab organizations. Research by Schuurman (2015)[29] indicated mortality rates of over 40% among the accredited living labs by ENoLL since 2006, which indicates that there is a problem with the sustainability of living labs. The last two groups of studies on business models deal with the organizational level, but none of these studies adopts a comparative approach.

Methodology

To take a first step towards a comparative analysis of the setup of living labs, the present paper develops a conceptual framework for the design of sustainable business models. Drawing information from a systematic scientific literature review by using a keyword search, from national funding schemes that deal with the creation of living labs, and from grey literature, we first list potential criteria that describe the design of business models and then cluster them according to basic categories (themes). Furthermore, a list of common elements[30] and key principles[31] of living labs helps to ensure that a holistic view is being maintained. Also various indicators that allow to assess whether associated criteria are being met or not are proposed in the framework. Then we present a case study featuring an Austrian example. The case study includes a test interview with the living lab manager of the Thinkport Vienna[32]. The interview results are used for framework testing in a deductive research setting. Learnings from the case study assist in revising the conceptual framework.

Thinkport Vienna –smart urban logistics lab is a living lab situated at the Port of Vienna, Austria. Founded in April 2017 it is a relatively young initiative which focusses on logistics challenges in urban areas. Thinkport Vienna is one of five mobility living labs which are currently operating in Austria, following a public funded exploratory study with a duration of 12 months. Its consortium consists of research organizations, private companies and city administration partners. The living lab case Thinkport Vienna provides practical insight and experience of a recent living lab establishment. Furthermore, the participation of the consortium in the exploratory study led to a solid knowledge base regarding potential living lab structures and possible difficulties. The case study allows to reveal important business model aspects by building on anecdotal evidence.

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[28] Mulvena, M., Bergvall-Kåreborn, B., Wallace, J., Galbraith, B., & Martin, S. 2010.
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[30] European Network of Open Living Labs. 2018. Common elements in living labs, http://www.openlivinglabs.eu/node/1429.
[31] Ståhlbröst, A. 2012. A set of key principles to assess the impact of Living Labs. *International Journal of Product Development*, *17*(1-2), 60-75.
[32] www.thinkportvienna.at

The conceptual framework for living lab business model structures has three dimensions (table 1).

Table 1 - Dimensions of the conceptual framework

Dimension	*Description*	*Relative importance for different types of living labs*			
Basic categories	Clustered theme	Living labs as pre-incubators	Living labs as a service	Living labs as extension to test-beds	Living labs as urban development instruments
Criteria	Descriptive characteristics of business models				
Indicators	Potential measurable states for an assessment				

Preliminary results and discussion

The conceptual framework for living lab business model structures (see annex) combines findings of scientific literature, guidelines of public living lab funding programs, business model canvas theory and practical experience in the establishment of living labs. It is designed as a questionnaire for living lab operators and, first, includes questions regarding general information of the living lab such as its legal structure or its action radius. The topics of interest of a living lab follow the ENOLL list[33]. Second, the framework includes basic categories, each clustered into several criteria, and a specification of the measure or possible answer (specifying potential indicators). The basic categories reflect one or several common elements and key principles of living labs. Common elements of living labs are (i) co-creation, (ii) multi-method approach, (iii) multi-stakeholder participation, (iv) real-life setting, and (v) active user involvement[34], whilst the five key principles which should permeate living lab operations include (i) value, (ii) sustainability, (iii) influence, (iv) realism, and (v) openness[35].

The basic categories *funding parties* and *cooperation aspects and market proximity* acknowledge the fact that cooperation, complementary expertise and an active risk management are important success factors for innovation to take place[36]. Questions in the basic category *funding shares* linked with questions of the category *organizational maturity* seek to gain insight into the strategic roles of different parties. Furthermore, the framework is designed to gather information of potential Do's and Don'ts when establishing a lab, including a better grasp gained in the basic categories *timeline of living lab establishment*, *development of turnover* or *organizational maturity*.

The test interview shows clearly that profit-driven living labs differ very much from common-welfare oriented living labs. Differences arise not only in regard to the division of funding shares or the development of their turnover. Their focus is very likely to influence the lab's key activities and long-term goals. The basic categories *strategic goals* and *key activities* allow to test this assumption. We expect that common-welfare oriented labs tend to focus on communication and conflict management in order to get to the bottom of shared and divergent interests of different stakeholders, whilst profit-driven labs tend to offer a clear package of fee-based services. Katzy (2012)[37] underlines the fact that one of the major challenges for living labs lies in generating revenues from private markets. The definition of consumer markets is especially challenging when

[33] European Network of Open Living Labs. 2018. Areas of work, http://www.openlivinglabs.eu/node/1429.
[34] European Network of Open Living Labs. 2018. Common elements in living labs, http://www.openlivinglabs.eu/node/1429.
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[37] Katzy, B. 2012.

dealing with inventions marked as ideas which have not been carried into practice yet[38] and early-stage innovations.

The basic categories *major customer segments*, *top 3 communication channels*, *public appearance* and *physical infrastructure* address the interface of a living lab with the public. The categories *level of activity in an innovation process* which addresses a certain innovation phase, the *role of a living lab* describing a living lab's basic task in an innovation process, and the *applied innovation methods* focus on the continuous, content-based interaction between the lab and its customers. The test interview underlines that a clear vision of the lab's development depends on long-term planning security and we assume that a potential time limit for the operation of a living lab has a significant impact on its organizational structure.

The conceptual framework offers a comprehensive and target-oriented look at a living lab's business structure. It allows a good overall view on the organizational aspects and a review of its strategy and business direction in light of its operational performance. The indicators allow to collect measurable data of different living labs which enable a comparison to be made of their development strategies and reality. We have observed that living labs follow different strategies in revenue generation, ranging from labs, which accompany the entrepreneurship and product development process to those, acting simply as instruments. Therefore, we take into account the variety of revenue generation paths. After data collection and analysis we aim to describe concise patterns of four different types of living labs, based on the literature. Until today, these types are described in a rather limited and qualitative way only. A clear definition would allow living lab operators to identify suitable best practices and role models and to make a better use of others learning effects:

1) Living labs as pre-incubators: accompanying and thriving the early start of the entrepreneurship process[39],
2) Living labs as a service: offering services such as designing real-world tests or idea-generation processes[40],
3) Living labs as extensions to test-beds, building upon a technical infrastructure[41],
4) Living labs as urban development instruments, funded and driven by the city[42];

In future studies, we aim at validating this typology by applying our framework to a sample of living labs representing the four types identified in the literature. This will allow to further describe strategies and operational mechanisms to increase the sustainability of living labs according to their type.

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Conclusion and outlook

The living lab literature analysed and mentioned in the chapter 'living labs & sustainability' demonstrates the strong need for a clear framework to assess the structure of a living lab's organizational level. This impression is confirmed by the high mortality rates among accredited living labs[43]. A comparative approach to analyse the business model structure needs to take into account objective evaluation criteria. Narrative descriptions and qualitative reports do not allow a clear identification of living lab types, which would offer the opportunity for a self-assessment of the organization and a practical guidance by learning from others' successes and failures. The designed conceptual framework is the first step in this direction. While the test interview in Austria was used for criteria testing, the next research step includes a case study and a test interview used for indicator testing in Belgium (imec.livinglabs). Further steps are the setup of an online poll and the collection and analysis of data. To conclude, we pose a series of potential hypotheses, which could be verified in future research:

Hypothesis 1: Living labs with a time limit of operation are most often research-driven.

Hypothesis 2: Living lab type 2 (living lab as a service) includes most of profit-driven living labs with a strong turnover development.

Hypothesis 3: Living lab type 4 (living labs as urban development instruments) includes most of the common-welfare oriented living labs.

Hypothesis 4: Common-welfare oriented labs tend to focus on communication and conflict management.

[43] Schuurman, D. 2015.

Annex - The conceptual framework

General information	Explanation / possible answer
Organization type (legal)	Open question
Country / Region	Open question
Topic	1:mobility, 2:health&wellbeing, 3:smart cities, 4:culture&creativity, 5:energy, 6:social inclusion, 7:social innovation, 8:education, 9:eGov/eParticipation (max. 3)
Action radius/spatial focus	1=district, 2=city, 3=region, 4=national, 5=international
Focus: Public good or profit-driven	Public good / profit-driven
Date of starting operational activity	Date
Is there a time limit for the operation of the LL?	YES / NO

Criterion	Common element / key principle	Measure of the criterion / possible answer
Funding parties of the Living Lab (with decision-making power)	Multi-stakeholder participation	
Involvement of the stakeholder groups: (a) research organisation, (b) company (incl. large companies and industry to SME), (c) citizens' representative, NGO, (d) city/municipality/ public authority		(a) YES / NO, (b) YES / NO, (c) YES / NO, (d) YES / NO
Internationality of the funding consortium (at least 1 partner)		YES / NO
Type of legal cooperation among funding parties		strong (e.g. legal entity, strong contract) / medium / weak (e.g. LOI)
Secured funding duration among partners		years (e.g. if contracts are renewed every year = 1)
Funding shares (today)	Influence	***Total=100%***
Share of public subsidies (no decision-making power)		%
If public subsidies >0%: Is the subsidy secured long term (more than 6 years)?		YES / NO
Public funding share (strategic participation as a consortium partner of the LL with decision-making power)		%
Private funding share (strategic participation as a consortium partner of the LL with decision-making power)		%
Research partner's funding share (strategic participation as a consortium partner of the LL with decision-making power)		%
Timeline of LL establishment	Sustainability	***Phases can be overlapping***
Pre-implementation phase (e.g. exploratory study, feasibility study of how to setup the LL, including to search for potential partners)		Date (if any)
Setup phase: starts when consortium is found. Includes first steps e.g. finding/building infrastructure, offices, drafting/signing contracts.		Date
Implementation phase: actual operational activity, thus, offering services to the market or opening of the (office) spaces		Date

(ONLY OF RELEVANCE IF THE FOCUS OF THE LL IS PROFIT-DRIVEN) Development of turnover (of service delivery)	Value	*** Since starting operational activities***
EUR in year 1		EUR / Full-time equivalent (FTE) employee year 1
EUR in year 2		EUR / FTE employee year 2
EUR in year 3		EUR / FTE employee year 3
EUR TODAY		EUR / FTE employee TODAY
Public appearance of the LL in the following ways (today)	Openness	***Total=100%***
Physical infrastructure		%
Virtual appearance (online forums, virtual tours, active blogging) (NOT including regular webpage)		%
Mobile presence (e.g. exhibition stands, moving units in the city such as containers, busses etc.)		%
Physical infrastructure (today)	Co-creation and realism	*** Does the LL use this kind of infrastructure?***
Pop-up spaces		YES / NO
Open Office and co-working space		YES / NO
Social Spaces		YES / NO
Exhibition spaces		YES / NO
Real Life Test Labor		YES / NO
FabLab		YES / NO
Does your LL have a specific key resource or a very unique and distinctive feature?	Value	open question
The role of the LL (today)	Influence and realism	*** Total=100%***
Incubator role (support the success of an idea, e.g. of startups and new founders)		%
Catalyst role (accompany the roll-out of a project)		%
Multiplier role (support the spread of a proven and innovative idea, service and/or project, including knowledge transfer)		%
Service oriented consultant role (offer specific services all over a project cycle)		%
Organizational maturity of the LL	Sustainability	
Is there a collaborative, formalized process of decision-making on the consortium level? If yes, please describe it.		open question
Is there a clear process of identifying innovation projects? If yes, please describe it.		open question
Describe two typical projects of the LL (topic, size, goal)		open question
Level of activity of the LL in the following innovation phase	Influence and realism	*** Total=100% / Take into regard the last year of operational activity***
Pre-incubator phase (awareness, market testing)		%
Incubator and development-phase		%
Implementation phase		%
Innovation methods used by the LL	Multi-method approach and active user involvement	*** Min: 0%, Max: 100% / Take into regard the last year of operational activity***
Idea scouting / Ideation		0-100%
Match making or connection of topics/people/interests		0-100%
Field tests		0-100%
Lab tests (directed towards a closed target group)		0-100%

UX evaluation (in daily routing / atmosphere)		0-100%
Ethnographic methods (e.g. participant observation to include virtually any group or organization)		0-100%
Workshops, World Cafés		0-100%
Key activities of the LL	Influence	***Take into regard the last year of operational activity***
1st		open question
2nd		open question
3rd		open question
Major customer segments of the LL	Value	***Take into regard the last year of operational activity***
1st		start-up / SME / large organization / multi-national / public organization / other Living Labs
2nd		start-up / SME / large organization / multi-national / public organization / other Living Labs
3rd		start-up / SME / large organization / multi-national / public organization / other Living Labs
Top 3 channels for reaching your top 3 customers	Openness	***Take into regard the last year of operational activity***
1st		print media / online / events / word to mouth / other (please specify)
2nd		print media / online / events / word to mouth / other (please specify)
3rd		print media / online / events / word to mouth / other (please specify)
Cooperation aspects and market proximity of the LL	Co-creation and influence	
Open access to the lab's infrastructure for all (public, partners, interested parties) is a daily routine for the LL		Not at all / Only rarely / For most of the projects / True, in any case
Openness towards other LLs is a daily routine (e.g. active involvement, sharing of midterm results, common brainstorming)		Not at all / Only rarely / For most of the projects / True, in any case
Protection of property rights is taken care of (e.g. written consent project/consortium agreement)		Not at all / Only rarely / For most of the projects / True, in any case
Active technical risk management is taken care of		Not at all / Only rarely / For most of the projects / True, in any case
Active commercial risk management is taken care of		Not at all / Only rarely / For most of the projects / True, in any case
The results of the projects can be directly passed on to the market (market proximity)		Not at all / Only rarely / For most of the projects / True, in any case
Strategic goals	Sustainability	***Order the goals according to your priority***
Strategic goal: Benefit of the society		1st / 2nd / 3rd / 4th
Strategic goal: Benefit of the environment		1st / 2nd / 3rd / 4th
Strategic goal: Benefit of economy		1st / 2nd / 3rd / 4th
Strategic goal: Benefit of research		1st / 2nd / 3rd / 4th