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Living labs in healthcare innovation: critical factors and potential roles of city governments

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13. Living labs in healthcare innovation: critical factors and potential roles of city governments

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1. INTRODUCTION

The term 'living labs' refers to a methodology of user-centric innovation in real-life environments within a wider network of relevant actors (e.g. Almirall et al. 2012). 'Real-life environment' refers to, among other things, living houses and hospitals; and 'wider network' refers to actors who have a stake in the innovation, in terms of providing funding or knowledge, or whose broader aim is to improve the healthcare system and make it more affordable. Since the early 2000s, the development of living labs has been closely linked to the rise of open innovation (Chesbrough et al. 2006) as the systematic exploration of a wide range of internal and external sources of innovation opportunities being integrated in the capabilities and resources of organizations. More specifically, living labs are closely connected to the emergence of purposefully engaging user groups (customers) in innovation (Von Hippel 1986, 2005; Thomke and Von Hippel 2002; Bogers et al. 2010; Priem et al. 2012). In these practices, the user's role has shifted from being a research object toward becoming a proactive co-creator of product and service innovation and improvement (Almirall et al. 2012). In healthcare, co-design and co-creation have been common practice for years (Nambisan and Nambisan 2009; De Couvreur and Goossens 2011).

Importantly, localized living labs are also seen as serving as platforms that support other networks within the local or regional economy (Katzy and Bücker 2015), for instance vertical networks in value chains and horizontal networks based on shared technology and skills. Collaborative networking practices – combined with certain levels of open innovation and co-creation – can lead to the development of new clusters (Lundequist and Power 2002) or reinforce existing clusters, which in turn can enhance innovation and contribute to transition in healthcare and medical systems. In particular, using the active input of users (patients, health professionals) as co-creators is an important way of better serving user needs, thereby speeding up innovation and transition (Shah et al. 2009; Edvardsson et al. 2011). As a specific innovation methodology, living labs can interact with local 'niche' environments and ultimately affect the 'regime' level, where the actual transition towards higher levels of sustainability takes place (see Chapter 1) (Geels 2010).

An increased sustainability in healthcare is required in order to deal with the ageing population and high levels of healthcare expenditure and its affordability (e.g. Bugge et al. 2015). However, inventions in healthcare are difficult to bring to market because of the large numbers of stakeholders involved, the presence of a strong regulatory system, a complex system of funding and reimbursement, entanglement within the trans-mural care processes, and complex product–service combinations (e.g. Guldemond and van Geenhuizen 2012; We-Care 2017). Ideas about how user-needs can be best served and how the goals of living labs can be realized are a fairly recent development (Nyström et al. 2014; Leminen et al. 2015; Leminen and Westerlund 2016; Logghe and Schuurman 2016; Ståhlbröst and Host 2016; van Geenhuizen 2018), with the exception of some early studies (Ståhlbröst 2008). As a result, many questions remain unanswered. In addition, thus far, little attention has been paid to how living labs can be linked to regional/cluster development and the same applies to the role of local governments in helping living labs become interconnected networks.

Against this backdrop, in this chapter, the following questions are addressed: What characteristics allow living labs to help bring healthcare solutions more quickly to market (application)? What roles can living labs play in supportive regional network development? And how can local governments enhance the developments in question? As far as methodology is concerned, we include four case studies involving living labs in the medical sector, one of which is in the socio-medical sphere. In three cases, the focus of analysis is on small-scale development and some specific inventions (elderly living, hospital refurbishment, refurbishment of shopping malls for wheelchair users), while the fourth case study focuses on the development of networks in a larger region. The chapter is organized as follows. The concept of living labs is addressed in Section 2. In Section 3, a set of critical characteristics is identified, based on a literature review and the three small-scale living labs, followed by, in Section 4, an exploratory analysis of regional networks from the perspective of a hospital. Next, in Section 5, the critical factors identified earlier are summarized with specific attention to the role of local governments, and some reflection is given. The implications of the present study and future research avenues are discussed in Section 6.

2. LIVING LABS: BACKGROUND AND CONCEPTUAL ISSUES

2.1 Background

The origin of living labs goes back to the early 1990s, when they were conceived as restricted city neighbourhoods designed to teach students to solve real-world problems with other stakeholders (Bajgier et al. 1991; Leminen 2015). The concept of living labs as used in research is credited to William J. Mitchell at Massachusetts Institute of Technology (MIT), who, in the early 2000s, based on insights into the potential of computing, sensing/monitoring and information technology, proposed moving various types of research from laboratories to real-life settings, such as buildings or even cities, making it possible to monitor user responses to inventions and observe their interaction with these inventions. A major contribution to the living lab concept came from research into the origin of innovations, in particular the idea of employing users as an important source. Thus, by drawing on the work by Von Hippel (1986) and Thomke and Von Hippel (2002), the focus shifted towards involving users more actively and early on in the process of creation and development of new products, processes and services (Hoyer et al. 2010). At the same time, as indicated earlier, the concept was fuelled by the recognized benefits of open innovation models.

In the next stage of development, the concept of living labs was 'embraced' by the European Commission in 2006 as part of a drive to increase the level of innovativeness of European countries and regions, resulting in the launch of a pan-European network of 19 living labs, under the umbrella 'European Network of Living Labs' (European Commission 2010; ENoLL 2012). Since then, living labs have emerged all over Europe in various waves, initially focusing merely on the introduction of new information and communications technology (ICT) tools, including healthcare as well as other areas of application, such as transport and reconstruction/refurbishment of buildings, including energy-efficient and net-zero buildings, and urban development. Next, North America joined Europe, for instance Canada, with projects such as refurbishing a shopping mall (Montreal, to be discussed as a case study) and campus initiatives mainly focusing on net-zero construction and energy efficiency (University of British Columbia, Vancouver, and Southern Alberta Institute of Technology, Calgary).

2.2 Conceptual Issues

The aim of living labs as a methodology in innovation can be described as follows: to speed up innovation and make it more efficient by matching user-needs in real-life environments at an early stage (Fahy et al. 2007). Accordingly, living labs can be applied in a wide range of contexts, from limited real-life physical environments and social settings (ENoLL 2012; Evans et al. 2015; Favela et al. 2015) to large-scale open innovation platforms and networks (Følstad 2008; Katzy and Bücker 2015).

Small-scale developments are often part of larger developments, which are connected to existing regional clusters or the active creation of such clusters, even in cross-border regions (Lepik et al. 2010). Clusters may provide the following advantages for the firms involved: suppliers of specialized inputs and facilities, as well as networks extending downstream to customers and laterally to manufacturers in complementary products/industries related by common technology (skills) (Porter 1998; Breschi and Malerba 2005). Integration into clustered networks allows firms to benefit from economies of scale and scope, as well as the ability to respond flexibly to quickly changing customer needs and global market conditions. Accordingly, applying a living lab environment in urban or regional policies can help enhance innovation through a large number of learning experiences involving firms, organizations, customers and other relevant actors.

Networks in living labs typically include various types of stakeholders, each with their own aims, interests and potentially different reasons for being involved (Soetanto and van Geenhuizen 2011):

- *User-groups:* having them co-create with designers and producers means that new products and services are better matched to their needs.
- *Universities/research institutes and their researchers and designers*: in co-creation with users, new solutions are developed and marketed more quickly; in addition, testing solutions in a real-life environment increases insight into user needs, which in turn enhances scientific knowledge.
- *Firms, large and small ones*: as producers or service providers, firms are part of the co-creation and user feedback process designed to increase customer value, shorten time-to-market and reduce market-based risks (through viable business models).
- *Organizations in a broader circle*: regulators, standard-setting institutes, financial investors, etc., are involved in inter-organizational learning to enable replication, up-scaling, and the application and commercialization of the inventions involved.
- *Local/regional authorities*: they can provide legitimacy to a living lab as neutral actors; they can also act as managers of living labs or as co-creators of public services, for instance in their primary services (e-governance), as well as in healthcare and education. Within a

broader context, they can act as mediators between different actors, and they can 'embrace' living labs as a concept in local/regional innovation (see Chapter 14 in this volume).

From a different perspective, the Triple Helix network of universities, business and government is also relevant. The aim of this network is to promote interaction and synergy and thus bridge the barriers between the three partners involved (Etzkowitz and Leydesdorff 2000; Etzkowitz 2008). Living labs are one (temporary) way of interaction at the micro-level, aimed at accelerating market introduction of a university or hospital invention, thereby organizing a Quadruple Helix by involving customers. Generally speaking, it stands to reason that, if the actors involved in living labs have different goals and there is insufficient alignment and common interest, new borders may emerge, affecting the application and performance of living labs. This is a common phenomenon in inter-organizational learning (Williams 2002; Harvey et al. 2014).

3. CRITICAL FACTORS

3.1 Overview of the Literature

In the current stage of implementation of living labs, it is still difficult to assess whether or not they attain their goals, or what is best in terms of user-composition or learning tools, given various differences in aims, means and end-goals. Also, living labs lack a sufficiently long history to conduct a systematic historic case evaluation. However, it is possible to determine whether particular conditions are obtained that allow living labs to perform adequately. Using a literature analysis in the first stage of the current study, six critical factors have been identified (Ståhlbröst 2008, 2012; Bergvall-Kåreborn and Ståhlbröst 2009; Dutilleul et al. 2010; Almirall et al. 2012; Leminen 2015; Nyström et al. 2014; Leminen and Westerlund 2016). We distinguish critical factors from other factors of influence on the results of living labs as those factors considered by experts (reports, interviews[1]) to be essential (or a 'sine qua non') to the results of the living labs or to realizing those results in a substantially more efficient way. The critical factors in question have to do with early user involvement and user feedback, real-life environment, stakeholder network and inter-organizational learning, external embeddedness and a structured innovation process, and each factor tends to be underpinned by a set of core values. Next, we adopted a case study design, as case studies can help explore and deepen our understanding of the relevance of the factors. In order to obtain rich results, we selected one patient-oriented living lab, two organization-oriented living labs, and one larger one, including regional network development.

3.2 Small-Scale Living Labs: Three Case Studies

Many living labs that are currently operational in healthcare innovation focus on the acceptance and use of ICT to support elderly people and people with a chronic condition, in what is also known as ambient assisted living. The aim of ambient assisted living is to allow people to live independently at home longer, through the use of smart homes or home automation, and possibly eHealth. The tasks involved are communication, protection through observation (and safety) using sensors and alarms, and possibly also increasing in-house participation in sports (fitness). eHealth can also be integrated, for instance for measuring blood pressure and blood sugar levels at a distance. Case study 1, in the Eindhoven region of the Netherlands, targeted elderly people of Turkish origin (Table 13.1). In providing accessible ICT tools, the aim was threefold: to enhance home care (low threshold Skype interface with care providers), home fitness training and health improvement, and home safety (sneak-thief detection and emergency button), by adapting technological solutions to specific users. The complexity was social in nature, given the cultural barriers with the user group (Kop 2011). The relationship of the living lab with the university was limited to an ex-post evaluation study (Van der Vloed and Sadowski 2013). The local government was mainly indirectly involved, through social housing and a regional organization for innovation, although it also acted as partner in the broader network.

The main challenge was involving the user-group, which was why learning about user needs began prior to the project design and why coaches from the Turkish community were involved; in some cases grandchildren acted as coaches. It was not necessary to structure the innovation process, because the number of expected inventions was limited, but the process was open and allowed users to show up with unforeseen innovative applications. Less attention was paid to the commercial aspects, although, after closing of the living lab, people were asked if they would be willing to pay for the ICT services, and only a few said they would be willing (Van der Vloed and Sadowski 2013). In terms of the adoption of the innovations, the target group became more involved in home fitness and improved physical health condition. They also accepted some ICT-based health and safety support, and suggested certain new home safety measures. It turned out that the core user values were linked to respect for culture and little engagement with ICT.

Table 13.1 Case study 1: elderly housing and ambient assisted living

Site	Doornakkers, Eindhoven (NL)
Working period	2010–12
Aim and means	Affordable healthcare and illness prevention, through increased use of ICT tools for homecare, fitness training and home safety
User involvement	Elderly people of Turkish origin; passive role but could switch to active
Complexity	Modest complexity: cultural distance with user-group
Physical setting	Living quarters: homes
Stakeholders network	Care provider; Eindhoven city; regional innovation organization; security services company, social housing provider
University	No (direct) involvement, but acting as external evaluator
Local government	Involved, but indirectly
Structured innovation process	Open structure, allowing new applications to be added to the project, but no selection procedures
Legal, ethical and cultural values	Cultural values of users
Critical factor(s)	Preparation: study of user needs prior to project design; involving specific coaches to develop trust
Outcomes on innovation	Increased use of ICT with better physical health condition of users (but low willingness to pay)

Sources: Kop (2011) and Van der Vloed and Sadowski (2013); adapted from van Geenhuizen 2018.

A similar but larger project in Amsterdam placed stronger emphasis on observing elderly people at home – using sensor technology – in particular, measuring their day-to-day activities and, in doing so, measuring their level of independence in living and need for support. The core values emerging in this project were the right to self-determination (the ability to switch off the monitoring system), privacy issues and transparency in decision-making involving the implementation of in-house ICT devices (Amsterdam Region Care and ICT 2013).

Case study 2 represents an institution-based living lab, that is, a hospital (Healthcare Innovation Centre Denmark (HICD) 2009). Health Innovation Lab (HIL) is part of a larger initiative in the Copenhagen area (Table 13.2). The aim of HIL was to design a methodology in healthcare innovations drawing on input from user-driven methods and simulation. These had to do not only with hospital design/renovation and refurbishment, such as of

Table 13.2 Case study 2: reconstruction of a hospital setting

Site	Healthcare Innovation Lab (part of Health Care Innovation Centre), Copenhagen, Denmark
Working period	February 2010–12 (demonstration projects)
User involvement	Clinicians and hospital (University Hospital Herlev), also patients with highly active and interactive (simulation) input [a]
Complexity	Multiple user groups; match of simulation practice with skills of patient-groups
Physical setting	Hospital (diverse rooms) and homes (eHealth)
Stakeholders network	Regional hospitals; capital region of Denmark and Danish Business Authority (both financial investors)
University	Input of domain and management knowledge (through university hospital)
Local government	Indirectly involved through regional network
Structured innovation process	Open process followed by narrower process in later steps (funnel model)
Critical factors	Conscious user selection and user training; trust creation between actors and open dialogue; team building; multi-disciplinary input
Outcomes on innovation	Sets of rules to which innovations need to respond; insights into the management of new innovation tools

Notes: [a] Simulation on the spot (simulation of real-life and imaginary situations to generate new ideas and inventions).

Sources: www.centerforsundhedsinnovation.dk and Ruff and Jacobsen (2012); adapted from van Geenhuizen 2018.

operating theatres and waiting rooms, but also with eHealth applications, for instance remote dialogue and monitoring and data retrieval from home readings. The overall goal was to realize solutions that were scalable and transferable to other hospitals in the region. In addition to patients, hospital officials and medical professionals were also involved as user groups. A key challenge was to establish a good match between user capabilities and skills involving the handling of simulation tools. Furthermore, this living lab – similar to case study 1 – has a limited focus on the commercial aspects because of the limited aims. By contrast, the university was highly involved, providing input regarding domain knowledge and training, while the local government was involved only at a distance, through a regional network.

With regard to structuring the innovation process, HIL used the funnel model, allowing for openness in the initial stages, while narrowing down the innovation process later on. Go/no-go decisions were less relevant in terms of commercialization, because the main output of HIL was a viable innovation tool to be used in hospitals in the region. However, if the solutions had to be brought to market, extended networking and inter-organizational learning would have been necessary, to be able to replicate and eventually upscale the solutions.

Furthermore, to improve performance, HIL organized training (e.g. for users working with simulation tools) and team building, to encourage all parties to interact and accelerate the design processes. Other best-practice factors were a multi-disciplinary input, trust creation and open dialogue, with a strong emphasis on 'human values', such as passion and risk taking among managers. Aside from providing insights into innovation management, the main outcomes of this living lab are sets of rules to which particular innovations in hospital design and eHealth need to respond.

The aim of case study 3 was to allow people with disabilities to resume their life, including shopping in a mall (Montreal) (Kehayia et al. 2014) (Table 13.3). In detail, the aim was to design better wheelchair navigation and location technology, in combination with a new reconstruction of the mall. The living lab was organized in such a way that the two main user-groups, people with disabilities and rehabilitation services providers, could adopt different roles in a mutual learning process, like co-creation and being part of focus groups. Although commercial partners were important, because they were responsible for dealing with co-creation and bringing solutions to the pilot stage, structuring the innovation process by a selection model did not appear to be an issue. With regard to boundary-spanning, this is the only living lab where all Triple/Quadruple Helix actors were involved and integrated. Also, university involvement has been comprehensive, in terms of knowledge input and management, even with collaboration from abroad.

With regard to values, ensuring strong commitment among the core actors was considered to be important, which is understandable, given the large number of actors. This living lab is also different from those in case studies 1 and 2, in that it was supported by broader activities, for instance communities of practice (CoP) and other participatory research methods, with the aim of improving knowledge-sharing in wider circles (Mazer et al. 2015). The key challenge was building a strong partnership within the network and adopting a multi-disciplinary and multi-sectoral approach, that included, for example, construction technology, navigation technology, shopping and transport behaviour, and psychology. The outcomes of the living lab can be summarized as product and process innovation in

Table 13.3 Case study 3: reconstruction of shopping mall

Site	Rehabilitation Living Lab (shopping mall Alexis Nihon), Montreal, Canada
Working period	2011–14/15
User involvement	People with disabilities and rehabilitation service providers: active role and changing types
Complexity	Multiple users, multiple sectors; many actors, including from abroad
Physical setting	A 'renovation'-ready shopping mall
Stakeholders network	Shopping mall organization and merchants, universities (including foreign ones), navigation systems firm, community-based associations, etc.
University	Input of multi-domain knowledge and of management knowledge to analyse the process (in other countries as well)
Local government	Involved more indirectly
Structured innovation process	Selection of promising solutions for pilots: not an issue so far
Critical factors	Keeping all actors deeply committed to project success; good quality rehabilitation research input; interaction with communities of practice (wider circles); multi-disciplinary and multi-sectoral approach
Outcomes on innovation	New solutions in wheelchair and navigation technology, refurbishing and path-signing in shopping malls; improved insights into multi-disciplinary and multi-sectoral aspects

Sources: Kehayia et al. (2014) and Mazer et al. (2015); adapted from van Geenhuizen 2018.

wheelchair and navigation technology, and in shopping mall refurbishing technology. Additionally, understanding of the multi-disciplinary and multi-sectoral aspects has improved.

4. A HOSPITAL LIVING LAB AS PLATFORM

4.1 Critical Factors

We now turn to an example of a living lab that acts as a platform and develops open innovation networks in the region, using Medical Field Lab (MFL) in Maastricht, the Netherlands. MFL originated at a trial office at the department of orthopaedic surgery at the university hospital (2005).

Its main objective was creating public–private collaborations between its own partners (medical specialists and researchers) and with firms within the areas of life sciences, medical technology and healthcare innovation. As such, MFL had a comprehensive mission with a broad area of application, with patients and clinicians as user-groups. The various critical performance-related factors of MFL are discussed below.

In cases such as MFL, because large firms are involved, the challenge is to avoid situations where large firms deter smaller ones from taking part. However, vertical cooperation within value chains has to be pursued to improve commercial results, implicating that solutions should be found for such contradictory situations. These solutions are rather time-consuming due to the necessary processes of boundary-spanning and balancing of interests. In addition, critical factors were found to be the availability and use of multi-disciplinary expertise and the one-stop shop approach, that is, providing a single point of contact and services. In complex organizations as hospitals and larger clusters of partners, easy access to a well-defined services system is vital to maintain an efficient and productive interaction. Another critical factor was expertise regarding funding programmes and access to a network of investors, providing a tailored set of financial services for development activities. This was combined with support for writing proposals, both for scientific grants and business plans. With regard to the structure of the innovation process, an idea, problem or need was screened for its potential value with respect to science, society and business, on the basis of which it was then decided whether the initiative was eligible for the project development phase. Subsequently, partners were invited and research and development (R&D) scenarios were formulated that resulted in project proposals for subsidy programmes (national or EU) and/or private investors.

4.2 Network Building

The role that living labs – in a broad sense – can play in early network formation in a region is now illustrated using MFL. The first achievements (around 2010) included collaborative projects between MFL (university/academic hospital) and various partners such as multinational companies, small- and medium-sized enterprises (SMEs) and other organizations. The networks we measured are *partial* networks in which the university/hospital is the central node, which means we disregarded networks between the partners and with partners other than the university/hospital. In the remaining section, we characterize the partners (type, location and project volume) and focus on project volume in/outside the cluster, to explore the cluster's relevance. In this context, it is worth noting that the Maastricht region (south of the Netherlands) is a cross-border area that includes border regions of Belgium and Germany. Also, it is worth noting that, prior to the MFL initiative, no comprehensive attempts were made to create a medical cluster, although there have been some collaborations between Maastricht, Aachen and Liege or Louvain. We use the term cluster in a spatially restricted sense, encompassing the cities of Maastricht, Eindhoven, Louvain, Hasselt, Liege and Aachen, an area that is almost identical with the EILAT area, a cross-border technological Topregion established in 2004. To imagine the distances involved, the maximum distance by road from Maastricht is 90 km (to Eindhoven and to Louvain in Belgium). Next, we include a somewhat larger area in our analysis, adding various medium-sized cities in the Netherlands (Breda, Ede-Wageningen and Nijmegen), at distances from Maastricht of 140–160 km.

With regard to the types of partner involved in the networks, SMEs tend to be the largest category, with a share of 50 per cent (Table 13.4). Multinational companies (smaller and larger ones) and education/research are the next largest partner types (with 20 per cent and 18 per cent share, respectively). Furthermore, outcomes regarding the spatial patterns of the networks indicate that 68 per cent of the partners are located within the larger cluster. With regard to the smaller cluster, that share drops slightly, to 62 per cent. Overall, the relationships tend to be spread over a somewhat large area. However, whether this is unique or conforms to other early networks of university/hospitals networks is impossible to determine, because, as far as the authors are aware, no similar research has to date been conducted. Of course, spread

Table 13.4 Medical Field Lab's networks around 2010

Characteristics		Absolute value (%)
Types of partner	• Government	2 (3.3)
	• SME	30 (50.0)
	• Multinational firms	12 (20.0)
	• Education/research	11 (18.3)
	• Healthcare providers	5 (8.3)
	All relationships	60 (100.0)
Location of partners	• Cluster (larger area)	41 (68.3)
	• Outside cluster	19 (31.7)
	• Cluster (smaller area)	37 (61.7)
	• Outside cluster	23 (38.3)
Project volume (euros)	Small (≤250,000)	34 (57.6)
	Large (>250,000)[a]	25 (42.4)

Note: [a]76 per cent are below 420,000 euros.

Source: Adapted from Guldemond and van Geenhuizen (2012).

Table 13.5 Smaller cluster: project volumes of Medical Field Lab's collaboration within and outside the cluster

Project volume (euros)	Absolute value (%)			*Chi square*
	Within cluster	Outside cluster	Total	
≤250,000	22 (61.1)[a]	12 (52.2)[b]	34 (57.6)	2.887*
>250,000	14 (38.9)	11 (47.8)	25 (42.4)	0.905
Total	36[c] (100)	23 (100)	59 (100)	9.152**

Notes:
*p<0.1; **p<0.01.
a 62.5 per cent within larger cluster.
b 47.4 per cent outside larger cluster.
c one missing value.

Source: Adapted from Guldemond and van Geenhuizen (2012).

of knowledge/research networks depends on the density of potential partners at different distances from the central node (university/hospital). We may assume that the area around Maastricht at the time was 'relatively thin', apart from DSM (bulk pharma) and Medtronic (medical devices).

In terms of project volume, most projects tend to be relatively small, with almost 80 per cent under €420,000, and almost 60 per cent under or equal to €250,000. At a more detailed level, it was interesting to see whether there is a difference in project volume between the cluster area and beyond. Table 13.5 indicates that, of all the projects partnering within the smaller cluster (36 in total), 61 per cent are relatively modest in size (defined here as under or equal to €250,000), in contrast with projects that are partnering outside the cluster (23 in total), where 52 per cent are relatively small. In the whole sample, the share of small projects is 58 per cent. If we take the larger cluster (shown in the notes to Table 13.5), there is not much difference in this regard, with 62.5 per cent of small projects partnering within the cluster and 47 per cent of small projects partnering outside the cluster. This leads to the conclusion that, among 'within cluster' partnering projects, the smaller projects tend to be somewhat overrepresented. The fact that larger projects are more common outside the cluster may be due to some important relationships with universities/research institutes and large companies abroad, for example with the Cleveland Clinic Foundation and Zin Medical in Cleveland, US, and Glasgow Caledonian University and Peacock's Medical in UK. Overall, the picture suggests that collaborative knowledge networks in the early years of cluster development were created in part locally, like with DSM Corp. as a public–private partnership in

Geleen, close to Maastricht, and Philips and TNO (applied research) in Eindhoven, while building relatively strong relations (given the volume of capital involved) to a somewhat larger extent took place outside the cluster and at a more global level.

5. LIVING LABS: SUMMARY AND REFLECTION ON CRITICAL FACTORS

5.1 Living Lab Performance

The key factors regarding the performance of living labs, based on literature and the case studies and interviews, are summarized in Table 13.6. The emphasis may vary, depending on whether the living lab is patient- or institution-oriented. In the latter case, more user-groups are involved, which makes them more complex to manage, while in the former case, specific user values tend to be important, particularly underpinning trust among users (van Geenhuizen 2018). Also, there may be differences depending on the importance of commercial goals, making the structure of the innovation process more important.

We can summarize the results as follows. With regard to the different points mentioned (Table 13.6), the way users are involved in co-creation tends to be most critical, followed by the way the stakeholder network is established and managed, and, equally importantly, the structure of the innovation process, with further steps towards commercialization. Within this context, it is not easy to identify critical factors with regard to building knowledge networks linked to living labs, but a few have emerged in our analysis, including expertise among the management of living labs in writing research proposals to build consortia and access on the part of management to investors/funding, which increases the chance of shaping collaborative networks successfully. And finally, it has to be emphasized that local governments do not play strong and direct roles in living labs in healthcare, as our case studies indicated. However, they may become more involved in future.

5.2 Role of Local/Regional Governments

Local/regional governments can take on different roles in living labs. A major role involves initiating and managing the so-called *urban* living labs that deal with place-based innovation in one or more areas (and domains) governed by local authorities, one of them being health, following the current empowerment of cities in this domain (decentralization). Other

Table 13.6 Critical factors in performance of living labs in healthcare

Factors	Points of note
Involvement of users in co-creation	• Early involvement • Motivation to participate • Capabilities and skills to participate • Critical user values • Absorption of user feedback • Timely preparation when vulnerable users are involved
Real-life environment	• 'Inviting' arena for development of meaning and sharing of improvisation, and creation and validation of inventions • Dealing with legal issues concerning access to living lab places and building of (ICT) infrastructure
Stakeholder network	• Avoiding large numbers of actors as well as avoiding a clear dominant one and strong interdependency • Maintaining openness and neutrality • Attention to changing roles (flexibility) • If necessary, multi-sectoral and multi-disciplinary approach • Sufficient inter-organizational learning to enable replication and upscaling of new solutions
Structured innovation (if commercial)	• Clear commercial aims, if desired • One-stop shop • Management support in proposal writing • Management access to investors/funding • A selection mechanism with transparent go/no-go decisions
Embedding of living lab	• Embedding in related collaborative learning communities (focus groups, communities of practice, etc.); supportive policy relations (region, sector)
Underlying values	• Ethical/legal issues, including legal liability, intellectual property-related issues, data access • User values: privacy, cultural identity, desire for self-determination, transparent decisions, cultural distance to ICT • Values in management: trust building, commitment, risk taking • Societal values: sustainability and responsibility to society

Source: Adapted from van Geenhuizen (2018).

areas are local traffic and the adoption of sustainable energy practices. Urban living labs started to mushroom as a result of evolving changes. In the early 2000s, ideas emerged about achieving urban sustainability, not only with new technology, infrastructures and data, but also with newly designed systems of services provision and delivery, markets, consumption, practices, etc. (e.g. in utilities) (Bulkeley et al. 2011; Voytenko et al. 2015), which marked the need for new forms of urban governance, in combination with new solutions to urban sustainability-related problems (Bulkeley et al. 2016; Evans et al. 2016; JPI Urban Europe 2016).

Encouraged by the Joint Programming Initiative (JPI) Urban Europe and the funding involved, many cities started to identify (parts of) themselves as urban living labs, often in overall development towards smart cities (Batty et al. 2012).

Unlike urban living labs, living labs in the healthcare sector do not provide clear indications about the immediate involvement of municipal governments. However, by providing social housing or homes for elderly people, cities can play a more direct role, as well as through upcoming urban policies for inclusive development for people with disabilities, prevention of various diseases through lifestyle changes, and by adopting a broader approach of living labs in local/regional innovation movements. In addition, the roles of cities are expected to grow, in particular as 'connectors'. Through their typically multi-domain position, local governments can help bridge inter-organizational boundaries. Based on our case studies in the healthcare sector, we suggest connecting:

- living labs and organizations in wider circles of living labs, including those providing a better embeddedness or experimenting in other ways, for instance in protected niches;
- different living labs, reinforcing the overall effects; and
- living labs and actors in open innovation networks and cluster formation.

Healthcare is usually a service provided by organizations that specialize in care and cure. However, given the new developments in prevention of diseases, including vitality and lifestyle programmes, and given the trend towards the decentralization of responsibility for particular healthcare services, cities may start to plan a more important role, and experiments may include other living labs, more so because city governments can adopt a 'holistic' perspective, connecting healthcare with housing quality and urban layout, for instance allowing people to be physically active near their homes.

6. CONCLUSION AND IMPLICATIONS

This chapter has examined the characteristics of living labs that are critical in bringing healthcare solutions to market (application) and ways in which collaborative networks designed to enhance the processes involved at a regional level are being established. In addition we looked at how local governments can facilitate these developments. Using a mixed-method approach, which included case study analysis based on reports, web-based information and interviews regarding innovations in healthcare for elderly people's housing, hospitals and shopping malls (refurbishment), we compiled a list of critical factors, without which the aims of living labs would be much more difficult or impossible to realize. The two most important factors are the involvement of user-groups and the involvement of a wider network of stakeholders, whose expertise and input match the complexity of the envisaged innovations. In addition, if commercial goals are prominent, adopting a selection mechanism with transparent go/no-go decisions, and specific skills on the part of the living lab management in terms of writing research proposals and acquiring adequate funding are also important.

Furthermore, we identified a trend that living labs perform better when they are embedded within a policy with other supporting practices at a local level. We observed some trends in early networking by living labs (university/hospital) involving research collaboration in early cluster formation. These trends, however, are difficult to interpret without similar research elsewhere for comparison. Overall, the results indicate the existence of both local and global networking, with an emphasis on the latter. In addition, various findings in this chapter point to a potential role that local governments may adopt, namely that of 'connector' between the various organizations involved in living labs, between different living labs, and between living labs and other experiments in urban/regional areas, alongside their role in urban living labs.

This chapter has some shortcomings, due to the use of a limited number of case studies. This includes little information on living labs in healthcare innovations and medical technology whereas no standardized information is available, mainly because there is no central problem-owner of such living labs. However, national ministries responsible for healthcare could build databases on medical and health living labs, in collaboration with city governments. Collecting data regarding the performance of larger numbers of living labs in a systematic way is required to monitor them and manage their aims and performance, including the identification of best and worst practices for different types of living lab. A database with a large number of living labs will also make it possible to determine the relative importance of the critical factors proposed in this chapter, using statistical analysis. This new research would support the establishment of a successful next generation of living labs and make healthcare more sustainable in the future.

NOTE

1. Personal interviews (MvG) with Iain Evans, 14 July 2015, UBC, Vancouver, Canada, and with James Evans, 14 April 2017, Manchester, UK.

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