

User-driven Innovation for Dementia Care in France: The LUSAGE Living Lab Case Study

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Abstract

The use of technology-based products and services for supporting older adults living with dementia, and their caregivers, has gained significant popularity in recent years. In this paper we present the case study of LUSAGE, a French Living Lab that has successfully adapted to provide the infrastructure, knowledge and services required to promote user-driven innovation in the context of dementia care by: (a) taking into account the needs and interests of primary end-users (patients, families, and care providers) and relevant stakeholders in the healthcare ecosystem; (b) encouraging the active involvement of primary end-users in all stages of the product design and development cycle, (c) conducting experimentations and assessments in real-life conditions, and (d) fostering value creation including individual, social and economic dimensions. By delivering a complete description of the implementation process and activities of LUSAGE over the last years, we identify factors that have influenced success and failure in innovation in this context. Finally, we suggest some promising directions for further development of Living Labs working in the field of healthcare and independent living.

Keywords

User-driven innovation, dementia care, assistive technology, Living Lab, ecosystem

Introduction

Dementia care is one of the biggest challenges that society faces today. To deal with the increasing number of persons living with dementia (PwD), authorities worldwide are working to improve their treatment and better support caregivers and families in a cost-effective way. This has been an important driver of change in the governance of health systems at the local, national and international scales, resulting in the reconfiguration of responsibilities for health policy, regulation and management (Jakubowski & Saltman, 2013). Part of this reorganization of the field is the progressive implementation of integrated care and case management practices for dementia care in several countries, including France (Koch et al., 2012). These approaches aim to provide a better coordination at the clinical and organizational levels and avoid the fragmentation between service providers (e.g., health vs. social, institutional vs. community based, private vs. non profit and public) (Somme & Stampa, 2011).

Considering that disease-modifying treatments for dementia are unlikely to become available before 2020 (Brodaty et al. 2011), effective non-pharmacological approaches are needed to promote independent living and enhance the quality of life of PwD. Thus, over the past decade, the number of Assistive Technology (AT) products and services aimed to support PwD and their caregivers has largely increased. AT for this population include devices that support carers, such as medication reminders, fall detectors, or GPS tracking devices, along with other technology-based systems aimed at improving the cognitive, social, emotional and physical environment of PwD, like social assistive robots, smart-home solutions, simplified videophones, or digital games for stimulation purposes (Lauriks et al., 2007; Carrillo, Dishman & Plowman, 2009). Far from being a replacement for personal care, these solutions complement the intervention of caregivers and may be used to alleviate their work.

Although limited by the small number of studies published to date, evidence-based findings from the assessment of AT solutions in this context are not only positive (e.g., improved quality of life for PwD and their carers, reduction of care costs, increased safety at home) but provide support for further development of these interventions (Buettner, Yu &

Burgener, 2010; Carrillo et al., 2009). Nevertheless, despite their proven usefulness, several barriers still hinder the wide deployment of AT for dementia care including: technology acceptance and usability issues, the lack of public awareness on existing solutions, reliability, scalability and interoperability problems, uncoordinated or inadequate funding, and difficulties to balance the interests of multiple stakeholders, end-users in particular (Nugent, 2007; Pino et al., 2014).

In this paper we present the case study of LUSAGE, a Living Lab (LL) created to investigate these factors and help stakeholders create effective solutions that would actually penetrate the market. LUSAGE is based in Paris (France) and is affiliated to both a public hospital (Broca Hospital, Assistance Publique-Hôpitaux de Paris) and a public university (Paris Descartes University). Since 2005, LUSAGE has been involved in more than 20 national and European projects dealing with the design, assessment and provision of AT for PwD. After providing an overview of the reasons behind the development of this LL, we describe key enabling and risk factors for this initiative. Then, we explain the implementation process of LUSAGE and deliver a panorama of its activities over the last years. Finally, we analyze the main results of the program, summarize lessons learned and identify challenges ahead.

Problem

The World Health Organization (WHO) estimates that 35.6 million people live with dementia worldwide, a number expected to double by 2030 (WHO, 2012). Dementia covers a group of symptoms including progressive cognitive and functional decline, challenging behaviors and other psychological manifestations (e.g., apathy, agitation, social withdrawal, or wandering), which can seriously compromise independent living at home and in community settings. As a result, effective dementia management includes the provision of regular medical and social services: medication, health monitoring, personal care, caregiver support, and preventive services.

In Paris, the increasing demand for geriatric healthcare services led to the creation of Broca

hospital in 1982. Then, in 1994 a Memory Clinic specialized in the diagnosis and treatment of elderly patients with cognitive disorders, due to conditions such as Mild Cognitive Impairment (MCI), Alzheimer's disease (AD), and other forms of dementia, was established within the hospital. In 2002, the department was labeled by the national authorities as one of the Expert Memory Centers of the Parisian region and was included in the EADC (European Alzheimer Disease Consortium), which regroups all the Expert Memory Centers in Europe.

Non-pharmacological treatments for PwD have been a traditional research area at Broca hospital from its beginnings (De Rotrou, 1992, 2011; Wenisch et al., 2007). In fact, the first structured cognitive stimulation program for PwD having showed a significant improvement in cognition and quality of life was developed at the institution (Breuil, 1994). Since the early 2000's the team has also developed and implemented various psycho-educational programs aimed at supporting and training caregivers of PwD (De Rotrou, 2006, 2011). However, two factors appeared to limit the wide implementation of these programs into clinical practice:

- a) *The necessity of a regular physical presence of participants:* With the progression of cognitive impairment PwD must at some point stop driving and are dependent upon others for transportation. This severely reduces their ability to attend the sessions. Also, when an informal caregiver is available, which is not always the case, finding the time to attend face-to-face meetings can be challenging, being often overwhelmed with managing his/her daily tasks and responsibilities;
- b) *Financial and human resources required for their creation and delivery:* In Broca's Memory Clinic 4500 patients consult per year and 2500 are followed up on a regular basis. Offering these programs to everyone raised the question of availability of trained staff and funding issues.

With the arrival of telehealth and the generalization of Internet use, healthcare professionals from Broca decided to explore the potential of Information and Communication Technologies (ICTs) to deliver these interventions. The major goal was to optimize the provision of care and support programs for PwD and their families by

reaching a larger number of recipients at a lower cost. That's how TANDEM, the first collaborative research project on gerontechnology at Broca, began in 2005.

TANDEM aimed at studying the acceptance and usability of an integrated system to provide PwD with computer-based cognitive stimulation and other functionalities. The solution was intended to play the role of an additional caregiver (Rigaud et al., 2010). A consortium of partners from different academic institutions and an SME was created for this purpose. Broca's professionals used their clinical expertise, some questionnaires and informal discussions with PwD and their caregivers to establish the specifications for this system. After conceiving a proof of concept, a seasoned ICT firm was commissioned to develop a functional prototype.

The system created did not entirely respond to the needs of end-users, mainly because of usability issues. Also, the project failed to reach technical maturity, essentially because of integration and interoperability issues. However, the experience was informative as it allowed the identification of factors regarding human computer-interaction in PwD and older adults with limited technology experience. General conclusions drawn from this experience were:

- Little was known about the use of AT to support cognitive functioning.
- Needs of PwD are very heterogeneous and changing, meaning that developing AT for this population requires a thorough and multi-dimensional assessment of their individual situation and iterative testing of AT solutions.
- Understanding the interaction of PwD with AT is only possible through direct and extended observation.
- AT acceptance by PwD and their caregivers is influenced by several ethical, psychological, and socioeconomic factors.
- Older adults are willing to use AT solutions, and get satisfaction from doing so, if products are tailored to their needs and abilities, so AT is a promising field in geriatrics.

Gradually, Broca hospital was acknowledged as an expert "end-user organization" by research and industry partners working on AT for older adults and thus, took part in several regional, national and European AT projects from 2005 to 2009 (Table 1).

The multiplication of research activities related to gerontechnology led to the conclusion that it was necessary to create a more structured framework for conducting the tasks normally assigned to end-user organizations (e.g., needs assessment, usability testing, clinical validation). Thus, it was proposed to create a LL, a concept that was understood at that time solely as a physical infrastructure to conduct formal usability testing with potential end-users under controlled conditions.

General Context

Several factors contributed to the maturation of the LUSAGE LL project including:

- (a) *The implementation of a national dementia strategy by the French government to stimulate investment and innovation in dementia research, prevention, and care.*

So far three Alzheimer's disease strategies have been implemented in France. The third one, "Plan Alzheimer", ran from 2008 to 2012. It was structured around three objectives: (a) improving the delivery of health and social care services for PwD and their caregivers through the implementation of an integrated care model and effective support programs; (b) supporting research on early diagnosis, pharmacological and non-pharmacological treatments; and (c) improving the quality of the information provided to patients and their relatives and raising public awareness about the disease (Chevreul, Durand-Zaleski, Bahrami, Hernández-Quevedo, & Mladovsky, 2010).

The "Plan Alzheimer" specifically recognized the opportunities offered by ICTs to support independent living and improve the quality of life of PwD and their caregivers (Ministry of Social Affairs and Health, 2008). Consequently, a budget of 4 million euros was allocated in 2009 to fund multidisciplinary national projects on home automation and AT. This initiative was coordinated by two key public actors: the National Agency for Research (ANR), tasked with funding scientific research, and the National Solidarity Fund for Autonomy (CNSA), responsible for providing financial aids for long-term care for older adults and people with disabilities. The program also supported the creation of a national reference center for the study of ethical issues raised by

dementia care. The Center for Ethical Reflection on Alzheimer's Disease (EREMA), established in 2010, has since then examined ethical, legal, and social issues related to dementia care, such as decision making and capacity to consent, respect for autonomy, management of complex cases, end of life, and the adequacy of care and support for PwD and their carers, in particular the use of AT (Ankri & Van Broeckhoven, 2013).

- (b) *Policies at national, regional and local levels sustaining a wider development and use of ICTs to support the delivery of health and social care services.*

The continuing support given to the sector of ICTs for health and social care over the last decade incited the development of LUSAGE. During this period, several public organizations have established funding programs to support clinicians, researchers and manufacturers, working in the sector. Prominent examples are the "National Network for Healthcare Technologies" (RNTS, 2000-2005), and its substitute "Technologies for Health" (TECSAN, 2006-2013) through a partnership between CNSA and ANR. The TECSAN program, endowed with a budget of 13-17 million euros per year, largely contributed to enhance the competitiveness of research organizations and businesses in the healthcare field and played a pivotal role in the implementation of the "Plan Alzheimer".

In the private sector, innovative businesses also benefited from national policies coordinated by the National Strategy for Research and Innovation (SNRI), including: support for business R&D through indirect and direct funding (e.g., research tax credit, OSEO innovation agency), public investment programs (PIA), support for knowledge transfer between public research bodies and businesses (in particular SMEs), and technological and industrial partnerships through the introduction of the Competitiveness Cluster policy in 2004 (OECD, 2012).

These policies have also resulted in the creation in 2009 of a National Reference Centre for Health and Independent Living (CNR Santé) by the Ministry of Economy, Finance and Employment. Some of its missions are: to stimulate the development and proper use of ICTs for health and social care at home, raise awareness among relevant

stakeholders, end-users and citizens on the interest of these technologies, build and disseminate solid and standardized methodologies for the development and assessment of healthcare ICTs, provide a regulatory framework and supervision for projects in this area. The CNR network comprises a central structure and various thematic Expert Centers throughout the country (robotics, mobility, cognitive stimulation, housing, etc.).

The recognition of the economic potential of the healthcare technology sector has also led to stimulate greater investment and innovation, at a local and European levels, with actions such as the creation of the "Silver Economy" Initiative by the French government (Ministry of Social Affairs and Health, 2013), the "European Innovation Partnership on Active and Healthy Aging" (EIP AHA), and the EU Framework Program for Research and Innovation "Horizon 2020" (European Commission, 2012, 2013), which particularly encourages the deployment of innovative and user-led pilot projects to support independent living in older adults with cognitive impairment through technology-based interventions. Globally, these strategies are intended to support healthcare innovation, earn the confidence of users and carers, improve their quality of life, promote active aging, and develop the market.

(c) The increased recognition of the benefits of user-driven innovation.

Multiple studies describe the advantages of actively involving end-users in the development and evaluation of healthcare technologies, a process called User-driven Innovation (Von Hippel, 2009); "actively" must be understood in the sense of co-creation and not only as the interaction of the user with the new product/service under development (Picard, 2010, 2011). Shah & Robinson (2007) conducted a literature review on this topic and found that the most commonly observed benefits of this approach are the generation of ideas by users, having direct access to users' perspectives, and the improvement of product design, functionality, usability, and quality. Of course, the authors also pointed out some drawbacks of this practice, such as the difficulty of recruiting a representative group of end-users and time and cost factors. Still, they concluded that the trade-off remains positive because it benefits both users and manufacturers. On the one hand, users have access to

technological products that really meet their expectations. On the other hand, manufacturers increase the marketability of their products and services.

That is why many funding bodies have incorporated requirements for the implication of end-users in their funding schemes for AT projects. The most prominent example is probably the Ambient Assisted Living Association¹, which has since its inception required that at least one end-user organization be part of technological projects to ensure that innovative solutions respond to actual user needs. Similarly, at the national level, most private funding bodies, which are usually non-profit organizations (e.g., France Alzheimer, Fondation de France, Fondation Médéric Alzheimer), require that proposals address user empowerment, referring to the beneficiaries' ability to influence the project (e.g. be involved from the very start and have a real say in decisions).

This trend also goes beyond technological innovation: the search for ways to better take into account the expectations of the users of healthcare systems in the areas of information, rights, choice, complaint procedures, safety and involvement has been an important issue of public debate. In France a pivotal act on the Patients' Rights and Quality of Care was passed in 2002 (Act no. 2002-303 of March 4th 2002). This Act defined: requirements of solidarity towards disabled people; principles of health democracy (in particular, the rights and duties of patients and health professionals); quality requirements of the healthcare system; principles for compensating victims of health hazards; and professional liability. It also further developed the role of patient associations, allowing them to act as patients' representatives, sitting on hospital boards and participating in regional and national health conferences (Chevreul et al., 2010).

Overall, LLs are now considered a key tool for the implementation of this 2002 law, as they encourage health institutions to integrate patients' views when planning care strategies. This results in more appropriate responses to user needs and reduces deployment costs, making it much easier to go from implementation to adoption. It also broadens the application of the LL methodology

¹ <http://www.aal-europe.eu/>

beyond its traditional technological focus, to the design, implementation, and iterative refinement of organizational or even regulatory innovations.

(d) *The establishment and development of local and regional LL networks*

Nowadays, the LL approach tends to spread in the industrial sector, and in many research laboratories, at various territorial levels (e.g., local districts, cities, regions) (Picard, 2010, 2011). Their recognition as initiators and catalyzers of change and cross-border collaborations in different systems (e.g., healthcare, urbanism, public services, manufacturing) explains why LL networks have gained increased visibility in the local and regional contexts (Eriksson, Niitamo, & Kulkki, 2005; Schaffers & Turkama, 2012). At the international level, the European Network of Living Labs (ENoLL)² has largely contributed to the formalization of the LL concept. Created in 2006 as an international, non-profit, independent association of benchmarked LLs, ENoLL supports the creation of a dynamic, multi-layer and multidimensional European Innovation ecosystem, and facilitates cooperation between members and external stakeholders. It now counts more than 340 accredited LLs all over the world.

At the national level, the French Forum for Autonomy and Health (FFAH)³ aims to federate the LLs operating in the field of health. It is one of the outcomes of a working group on LLs in the sector of health and independent living, coordinated by the High Council for Economy (CGEJET, 2009-2011) in partnership with the Ministry of Social Affairs and Health. Participant LLs and related organizations joined in 2012 in an informal forum, the FFAH, to federate local initiatives and foster greater collaboration between LLs and other stakeholders. FFAH allows its members to mutualize equipment and cohorts, share knowledge, and exchange best practices to converge towards common, validated and eventually standardized methods and outcome indicators. Issues addressed are specific to the health sector and include: the ecosystem, business models, organizational and ethical aspects, laws and regulations, service interoperability, and evidence dissemination. More generally, FFAH

enables LLs to make themselves heard more effectively in the public debate and help raise awareness about their work, especially how it goes beyond experimentation in home-like laboratories and aims to assess solutions in the real world.

The FFAH is now implementing a coordination process with France Living Labs⁴ (F2L), whose aim is to develop a network of French LLs in the different sectors of the economy, representing the French chapter of ENoLL.

Enabling Conditions & Risk Factors

Broca hospital directly benefited from national policy reforms pertaining to the care of older people, dementia strategies, and the use of ICTs for healthcare, as well as from the increasing proportion of public and private funds allocated to these sectors. For instance, the team was able to participate as coordinator or partner in different projects funded under the thematic programs RNTS and TECSAN, and was designated as host institution for the National Expert Center in Cognitive Stimulation (CEN STIMCO) by the CNSA. Furthermore, Broca's active engagement in the use of non-pharmacological approaches for dementia care, in particular the use of AT to support patients and carers, allowed the organization to build a reputation for its scientific expertise and social and ethical involvement.

Creating a LL seemed appropriate to keep the momentum gained through all these activities, as well as actively participate in the global effort of the national health system to open up towards citizens and develop home care, which requires innovative yet reliable field-tested solutions. Furthermore, in the case of PwD, whose care raises specific ethical issues, it was clear that such a LL could only exist in a public setting, as no privately run initiative would have the legitimacy and neutrality necessary to undertake such activities with enough confidence from the public.

Nevertheless, some risk factors to the development of this initiative were identified, such as: inadequate funding, lack of cooperation between stakeholders, inappropriate resources, uncertainty about attitudes towards innovation within a rather

² <http://www.openlivinglabs.eu/>

³ <http://www.forumllsa.org>

⁴ <http://www.france-livinglabs.fr/>

conservative public hospital environment, unrealistic expectations about the potential of AT to support dementia care, and the complexity of involving PwD and their caregivers in LL activities.

Solution and Implementation

The official establishment of the Living Lab LUSAGE was possible in 2009 thanks to “France Alzheimer”. AP-HP supplied the facilities to settle the LL within the hospital. External funding was used to set up a technical platform replicating a “home environment”, enabling the observation of users interacting with different technologies under controlled conditions. Assessment in real-life conditions could be conducted at the different hospital departments, local adult day-care centers, or in the user’s own environment.

User Involvement

LUSAGE strives to involve end-users (PwD, healthy elderly individuals, families, and informal and professional caregivers) in all stages of product development; they may participate either occasionally or in regular user-groups. PwD are recruited from Broca’s Memory Clinic, Centers for Local Information and Coordination (CLICs), and local Alzheimer’s associations. Healthy elderly persons are recruited through seniors associations. Informal and formal caregivers are recruited through the regional hospital network. End-users that volunteer to participate in LL activities are provided with adapted and comprehensive

information about the projects and are required to give written consent for their participation, being free to withdraw from the project at any time.

Evolution of the Project

At its beginnings LUSAGE prolonged the role of “end-user organization” in continuity of the first research projects in gerontechnology conducted at the hospital. This role implied, almost exclusively, the execution of user-research tasks: user profiling, needs assessment, iterative development and prototype assessment, and final product evaluation.

Today, LUSAGE studies the factors that influence not only the development and assessment but also the provision and adoption of AT solutions in the context of dementia care. These include micro-level factors, related to individual users (e.g., needs and characteristics, accessibility requirements, individual context of use, perceived value of the solution, individual ethical standards) and macro-level factors, related to a variety of stakeholders and the socio-economic, organizational and infrastructural characteristics of the ecosystem (e.g., public health policies, regulatory issues, quality standards, business models, public-private partnerships, ethical and societal aspects). Thanks to its external position, LUSAGE contributes to bridge the gap between the primary user and the stakeholder network, providing the conditions for technological and social innovation in a win-win situation (Figure 1).

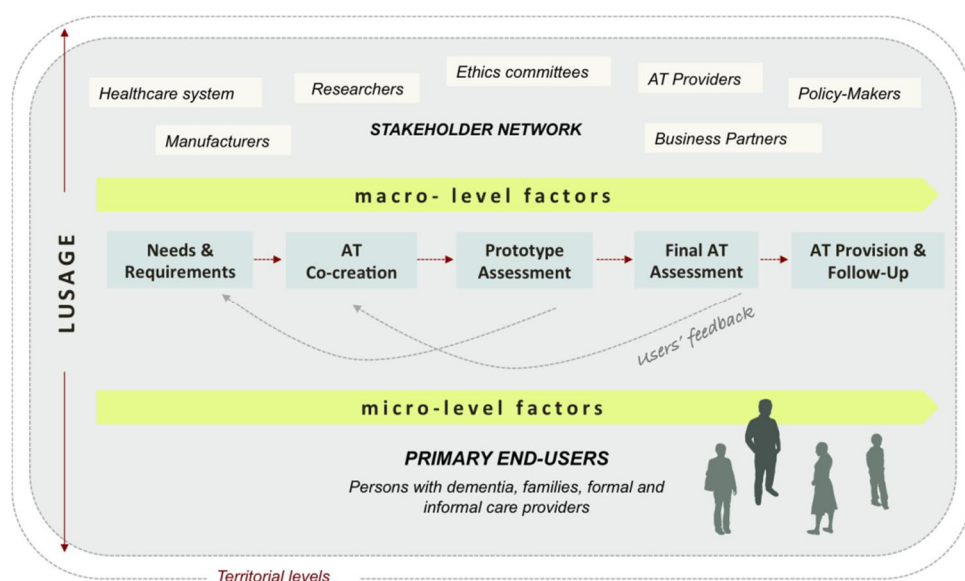


Figure 1 LUSAGE Living Lab Scope and Activities

The evolution of LUSAGE's role is clearly illustrated by the nature of the projects in which it has taken part. Most of the initial projects dealt with AT design and development (e.g., TANDEM, CompanionAble, ROBADM), while today they include several research topics (e.g., user empowerment, social participation, healthcare policy, stakeholder networks, organizational and ethical aspects, business models, evidence dissemination). For instance, the project "Gerontechnology & You" (2011-2012) aimed to enable older adults to make informed choices regarding the use of AT products and services. By providing a hands-on experience with commercial AT solutions and collecting the views of potential end-users, the team also intended to better understand the ethical issues associated with AT use in old age and design efficient and respectful procurement and training approaches. Another example is the project ITHACA (2014-2016), which studies policy, organizational, and regulatory factors at a local and national levels that may influence the inclusion of AT within individual care plans for PwD. The study also intends to assess awareness among healthcare professionals and end-users of existing AT solutions and provision methods. Results from ITHACA are expected to allow the creation of user-driven, effective dissemination strategies for AT in dementia care.

Ecosystem

The LL approach is based on the endeavor to promote cooperation between stakeholders for the

development of valuable and innovative technological products, services, and markets (Bergvall-Kareborn, Hoist, & Stahlbrost, 2009). Therefore, in LUSAGE, primary end-users, large companies or SMEs, policy-makers, research organizations, civic sectors, health insurers, representatives of ethical committees, and other relevant stakeholders, are committed to work together to design innovative AT solutions and participate in experimentations conducted in real-world settings. These collaborations are engaged at all territorial levels (district to international).

Figure 2 presents the ecosystem in which LUSAGE evolves, distinguishing three levels, by order of proximity. The closest level includes actual people directly involved in experiments and other LL activities. They may be affiliated to institutions of the second or third levels, but it is mostly their personal input as primary end-users, early adopters, disruptive innovators or field experts that drives the LL forward. The second level contains institutions that may directly collaborate with the LL in specific projects and occasionally contribute to general LL activities. Finally, the third level includes all the institutions that do not directly take part in innovation projects but indirectly determine the context in which those innovations emerge; LL professionals must reach out to them when necessary to better understand their positions and raise their awareness on issues that demand broad change in terms of infrastructure, regulations, policies etc.

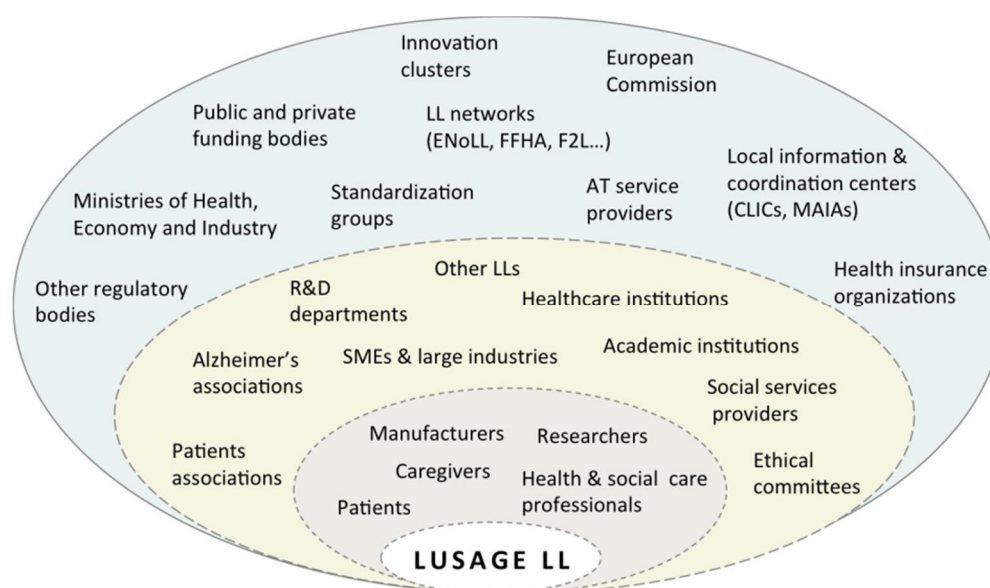


Figure 2 Ecosystem of the Living Lab LUSAGE

Success and Failure Factors

Key success factors for the development of LUSAGE were:

- (a) Continuous support received at all levels from policy makers, public and private organizations with stakes in dementia care by means of funding and regulation. Primarily, expected workforce shortages in the field of elderly care has contributed to the decision of supporting research and development of AT to ease the burden of informal and professional caregivers.
- (b) Creating a highly multi-disciplinary team, involving healthcare professionals with backgrounds in medicine, gerontology, psychology, occupational therapy, and speech-language pathology. Considering that one of the main goals of AT for dementia care is to compensate for cognitive impairment, the team's experience in evaluating cognition and frailty also was a great asset.
- (c) The affiliation to a public geriatric hospital, with a long experience in the diagnosis and treatment of memory loss has facilitated the recruitment of primary end-users for LL activities. Approximately 8000 older adults consult in Broca hospital network per year, making LUSAGE an attractive partner for companies that develop healthcare technological applications and services.
- (d) Having a convenient location and offering accessible facilities. LUSAGE is located in the centre of Paris, easy to reach by public transportation and accessible to people using mobility aids. Efforts have been done to ensure that LUSAGE is also accessible and easy to navigate for PwD so they feel confident when visiting.

Some factors that have limited the development of this initiative are:

- (a) Short-term, strongly constrained funding, which has often prevented LL-based solutions from panning out into the market. Understanding and taking into account the needs and motivations of users takes time and often leads to reconsider a project entirely. However project regulations require that the

entire budget be spent over a determined period (one, two or three years usually), which often prevents teams from incorporating the key insights offered by users through iterative testing. Furthermore, the necessity to explain in detail what the final product will be in order to get funding forces teams to work in a given direction that rarely can be overturned completely, even if end-user inputs reveal that the initial direction taken was wrong, making the principle of "user-driven innovation" less useful.

- (b) It is increasingly recognized that the LL approach is particularly adequate for involving PwD, whose needs and capabilities are notoriously difficult to formalize, in innovation activities. However, implicating these users in LL activities is a resource-demanding task that can only be accomplished by properly trained staff. The economic and social value of user-driven innovation within the context of dementia care must thus be better measured and publicized: this will encourage funding/investing bodies to allocate a higher percentage of resources to LL activities within their projects.
- (c) No proper business model exists as of today for public sector LLs in the French healthcare system. Indeed, legal and administrative complexities make it difficult to offer a streamlined, industrialized service to innovative solution providers, who are increasingly interested in LLs but are used to working in the simple, flexible framework of the innovation economy. More agile structures at the frontier of the public and private sectors like the non-profit CEN STIMCO, which contracts with industrial partners and then sub-contracts with public sector structures like LUSAGE, are beginning to provide solutions to this.

Results and Impacts

Main economic and societal consequences of the LUSAGE project are:

- (a) By integrating end-users' knowledge into AT research and development, LUSAGE has contributed to the design of operational and effective AT solutions for PwD and caregivers,

in terms of early acceptance, usability, accessibility, security, clinical effectiveness, and user empowerment. Therefore, these user-driven solutions are expected to gain faster access to markets.

- (b) Increasing awareness of the opportunities provided by AT to support dementia care among all stakeholders, including PwD, caregivers, funding bodies, policy makers, and citizens in general.
- (c) Through continuous research and experimentation, LUSAGE has developed structured methodologies to involve PwD and their caregivers at the different stages of the design cycle, improving knowledge in the field of human factors/ergonomics. Research findings from LUSAGE have also added substantially to the understanding of the attitudes of PwD and caregivers towards AT, and provided additional evidence with respect to the benefits of AT interventions for dementia care.

Table 1 describes the projects in which LUSAGE has been involved and presents key performance indicators including:

- Total number of projects in which LUSAGE has participated from 2005 to 2014 (n=26).
- Total number of AT-related areas tackled by these projects (n= 6).
- Total number of end-users directly involved in LL activities (evaluations, co-design, training), which includes older adults (PwD, healthy older adults, frail elderly and individuals living with other chronic conditions), informal and formal caregivers (n=1505).
- Total number of industrial partners directly involved in collaborative projects (n= 43).
- Total amount of funding received to support R&D and scientific research (2 424 773 Euros).
- Total number of dissemination actions (n= 122).
- Membership to LL networks: ENoLL and F2L (2012), FFAH (2013).

Table 1 Description of Projects and Key Performance Indicators for the Living Lab LUSAGE (2005-2014)

Area	Project (Territory)	Description	End-users involvement (Number)	Final outcome	Dissemination channels	Funder (Period)	Funding received (Euros)
Tele-health	TANDEM (FR)	Integrated support services for OACD living at home, FC and IC	OACD (119), IC (27), HOA (22), IND (1)	Proof of concept Working prototype Guidelines TA/IHM	Papers (6) Conference (12)	Médéric Alzheimer (2005-2007) ANR-RNTS (2006-2009)	50 000 177 320
	Memosyne (FR)	Delivery of CS and support services for HOA	HOA (120), FC (3), IND (1)	Working prototype Guidelines TA/IHM	Papers (3) Conference (2)	DRASSIF (2005- 2007)	50 000
	VASSIST * (EU)	Voice control system for communication and telehealth	OA chronic conditions (46), FC (9), IND (4)	Working prototype Guidelines TA/IHM	Papers (1)	EC- AAL (2010-2013)	119 783
Platform & Networks	LUSAGE (Regional)	Set up and furnishing of a LL platform	Multi-stakeholder	Technical platform Guidelines LL methodology	Public events (2) Website (1) Papers (3) Conference (4)	France Alzheimer (2009-2011)	50 000

	CEN STIMCO (FR)	Creation of a National Expert Center on CS	Multi-stakeholder	Consolidation of a stakeholder partnership, guidelines for the assessment of AT for cognition	Public event (4) Website (1) Conference (6)	CNSA Private donation (2010-2013)	350 000 300 000
	ENoLL (EU)	European Network of Living Labs	Multi-stakeholder	Membership (6 th wave of certification)	Public events (1) Website (1)	Since 2012	N/A
	FFAH (FR)	French Forum for Autonomy and Health	Multi-stakeholder	Membership	Public events (1)	Since 2013	N/A
	F2L (FR)	France Living Labs	Multi-stakeholder	Membership	N/A	Since 2012	N/A
Social Assistive Robotics	QuoVADis (FR)	Development of a social assistive robot to support older adults (PwD, frail OA, HOA) and informal caregivers	OACD (103), IC (30), HOA (28), IND (2)	Working prototype CS software	Website (1) Papers (6) Conference (5)	ANR-TECSAN (2007-2010)	160 800
	CompanionAble (EU)		OACD (80), HOA (28), FC (40), IC (30), IND (5)	Working prototype Guidelines TA/IHM	Website (1) Papers (3)	EC- FP7 (2008-2011)	232 590
	ROBADOM (FR)		OACD (18), HOA (55), IND (1)	Working prototype Guidelines TA/IHM	Papers (4) Conference (2)	ANR-TECSAN (2009)	214 302
	PRAMAD * (FR)		OACD (10), IC (10), HOA (57), IND (2)	Working prototype Guidelines TA/IHM	Papers (1) Conference (2)	Region IdF- FUI (2011-2014)	215 205
	Paro (International)	Evaluation of therapeutic robot for OA with severe dementia	OACD (10), FC (90), IND (1)	Clinical evaluation Guidelines for use	Public event (1) Papers (3) Conferences (2)	AIST (JP) DTI (DK) (2009)	N/A
E-learning	HCNV (EU)	Remote training for FC working with OACD	FC (196), IND (2)	Working prototype Guidelines TA/IHM	Conferences (3)	EC – LLP Socrates (2005-2007)	44 406
	ANGELS* (EU)	Augmented Reality for Safety in Healthcare Environments	FC (36), IND (3)	Working prototype Guidelines TA/IHM	Public event (2) Website (1) Conference (1)	EC – LLP Leonardo (2013-2014)	35 261

	DIAPASON (Regional)	Psycho-educational program for IC of PwD	HOA (31), IC (65), FC (15), IND (1)	Working website Guidelines TA/IHM Clinical evaluation	Website (1) Paper (1) Conference (14)	PREQHOS Médéric Alzheimer (2010-2013)	42 000 24 690
AT for Compensation and Stimulation	T&T Net* (EU)	Cognitive assistance for navigation	HOA (7), IND (5)	Working prototype Guidelines TA/IHM	Website (1) Conference (1)	EC-AAL (2011-2013)	65 156
	TROUVE* (FR)	Cognitive assistance for item location	OACD, FC, IC, IND (1)	<i>Expected: Working prototype Guidelines TA/IHM</i>	<i>Expected: Papers (3) Conference (3)</i>	ANR-TECSAN (2013-2015)	105 060
	AVATAC* (Regional)	Virtual agents for cognitive assistance	OACD, FC, IC, IND (1)	<i>Expected: Working prototype, Guidelines TA/IHM</i>	<i>Expected: Papers (3) Conference (3)</i>	Region IdF (2013-2016)	102 200
	Wii usability* (Regional)	User-tests for the Wii with OA having different cognitive profiles	OACD (12), HOA (12), young adults (12)	Guidelines TA/IHM	Papers (2) Conference (3)	N/A.	N/A.
	Minds (Regional)	Development of a music therapy game for PwD	OACD (40), FC (20)	Final product Clinical evaluation Guidelines for use	Public event (8) Papers (3) Conferences (4)	Charles-Foix gerontechn. grant Region IdF-OSEO	12 000 25 000
User empowerment, E-inclusion & Framework for AT Provision	ITHACA* (FR)	Framework for including AT solutions in dementia care plans	Multi-stakeholder	Case-study France AT database for dementia care	<i>Expected: Public event (1) Papers (3) Conference (2) AT database (1)</i>	France Alzheimer (2014-2016)	50 000
	Gerontechnology and you (Regional)	Promote informed choices for AT through a set of hands-on experiences	HOA (205) INDs (15)	Final report and public event	Public event (1) Newsletter (1) Papers (2) Conference (2)	Fondation de France (2012-2013)	24 000
	Café Multimedia* (Regional)	Promote E-inclusion and social participation through ICTs	<i>Isolated OA (30-50)</i>	<i>Final report</i>	<i>Expected: Newsletter (1) Public event (1) Papers (1) Conference (2)</i>	Fondation de France (2014-2015)	12 000

Total	National (11) Regional (8) European (6) International (1)	OACD =392 IC=97 FC=409 HOA=565 INDs= 43	Websites= 8 Public events= 19 Papers= 36 Conferences= 59		2 424 773
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*= Ongoing projects, AAL= Ambient Assisted Living, AIST= National Institute of Advanced Industrial Science and Technology, ANR= National Research Agency, AT= Assistive Technology, CNSA= National Fund for Solidarity and Autonomy, CS= Cognitive stimulation, DRASSIF = Regional Direction for Sanitary and Social Affairs, DTI= Danish Technological Institute, EC= European Commission, EU= Europe, FC= Formal caregivers, FP7= 7th EU framework program, FR= France, FUI= Fonds Unique Interministériel, HOA= Healthy Older Adults, IC= Informal caregivers, ICTs= Information and Telecommunication Technologies, IdF= Ile de France Region, IND=Industrial partners LL= Living Lab, LLP= Life Learning Program, N/A= not applicable, OA= Older adults, OACD= Older adults with cognitive disorders, PwD= Persons with dementia, RNTS= National Network for Healthcare Technologies, TA/HMI= Technology acceptance/Human-Machine Interaction, TECSAN= Technology for Healthcare

Shared value creation of the initiative and other secondary impacts of the program are:

- (a) Knowledge-transfer: Teaching activities related to gerontechnology, AT and dementia care in different educational institutions, corresponding to approximately 1200 hours of teaching in higher and continuing education programs.
- (b) Standardization and dissemination : participating in national and European LL networks (ENoLL, France Living Labs, French Forum for Autonomy and Health), LUSAGE has been actively contributing to the exchange of LL good practices related to user-driven innovation in the context of dementia care, the dissemination of evidence and the transferability of effective AT solutions to other localities, regions and countries.

Some Surprising Results

In our experience, older adults, PwD and their families are often willing and able to participate in LL activities. Being a full actor in the process of co-construction of AT solutions improves their self-esteem and their feeling of social inclusion. Furthermore, the presence of a LL within the hospital has contributed to change the views of patients on the role of public hospitals, which become not only providers of care but also a catalyst for user empowerment and social participation.

Lessons Learned and Challenges Ahead

LUSAGE is one of the first European experiments for the implementation of a LL in the context of dementia care; recently, similar initiatives have been launched in this area (Roeg, Snaphaan, & Bongers, 2013). The analysis of LUSAGE activities over the last decade enables us to derive lessons for the replication of the concept:

- (a) **Establish a stronger link to overall health policies:** Innovation in dementia care requires examining how results can be integrated within global health policies and the associated legal, regulatory, and organizational framework. Questions such as: how can the new solutions be integrated into existing models of care delivery? who is going to pay for the new services? how can we ensure sustainability and competitiveness of business in the AT sector? and, how can we deal with potential organizational barriers? need to be fully addressed.
- (b) **The Living Lab as a mediator:** LL projects in the field of dementia involve diverse actors (Figure 2); successful innovation is thus highly dependent on effective collaboration between parties. However, establishing a multidisciplinary consortium does not guarantee real cooperation and learning between stakeholders. Thus, the LL has to provide the framework and conditions for actors to benefit from each other, playing the role of mediator. This comprises assisting the parties in the identification and articulation of their own interests, priorities, and needs, and

encouraging the definition of agreements and common objectives.

(c) Establish a dissemination plan: A well-designed dissemination plan should ensure that outcomes of LL activities benefit users, stakeholders and society. Thus, developing and implementing timely and effective dissemination strategies towards primary end-users, members of the scientific community, industry, media, policy makers and citizens, is highly recommended. Fortunately, the Living Lab approach is very useful in this regard. Through iterative testing and documentation, solutions reach high robustness, and replication from one context to another becomes easier when building on lessons learned from previous efforts.

(d) Innovation within an ethical and legal framework: The LL approach is particularly welcome in the health and social services sector because it allows the integration of patient choices in the design of care solutions that directly concern them, resulting in solutions that better meet their needs, and are less expensive to develop and maintain. But involving PwD in LL innovation strategies requires particular attention to ethical and legal issues. Guidelines governing innovation and research projects should be defined in parallel with the project plan. Local organizations that support PwD and their families can provide information and advice on these topics.

(e) The need for more objective measures of success: The overall positive experience that results from LUSAGE activities is closely related with the high degree of user involvement in the different projects. However the impact of user-driven innovation in the field of healthcare is hard to measure, mainly because it involves multiple factors, for instance: creating acceptable and usable products, promoting social value, supporting user empowerment, improving users' quality of life, generating savings at different levels, or enhancing marketability. Further research is needed to build and test impact indicators for user-driven innovation in order to better understand the value of this approach.

(f) Going beyond design and development: The dissemination of innovations is a major challenge in all industries, including health care. Accordingly, since the beginning, LLs have tried to extend their activities beyond design and development and gain a more active role in the provision of AT products (e.g., design of support services and dissemination strategies). However consistent policies and resources are needed for this, as well as greater confidence from industrial partners, all of which will come only when better quantitative, macro-scale evaluations become available to support the effectiveness of the LL approach in terms of social and economic return on investment (ROI).

Conclusion

LL methodologies represent a new approach for innovation that has gained popularity over the last decade in different sectors: health, transport, urbanism, business, and industry. Its originality lies in the active participation of primary end-users and concerned stakeholders for the conception of products and services. Within this approach end-users play a central role contributing to the innovation process with their ideas, experiences, practices, desires, needs, and frustrations. The rationale behind this process is that it is the usage of the product that creates its value, and thus that this value is not completely predictable.

Experiments conducted within LUSAGE over the last years lead to the conclusion that user-driven innovation in the context of dementia care is not only possible but also highly desirable. This experience can be related to other initiatives and scenarios of smart cities development, which focus on age-friendly services or universal accessibility.

From our point of view, integrating and coordinating these efforts will prove critical in the near future. The ongoing structuration of specialized LL networks, such as the FFAH, should prove useful to this end. It will enable LLs to mutualize resources and standardize methodologies to ensure replicability and provide solid, opposable results, in order to guide the numerous public and private efforts being made to adapt our environment to the growing number of PwD who live at home and aspire, like any other

citizen, to remain independent and included in society.

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